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CONTRIBUTIONS:

All Letters and Contributions intended for Publication should be addressed to:—
K. R. DOGGETT, Editor,
"The Dock and Harbour Authority,"
19, Harcourt Street, London, W.1.
Telephone: PADdington 0077/8.

The Dock & Harbour Authority

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Editorial Comments

The Port of Bangkok.

Bangkok, the capital and chief port of Siam with a population of nearly 1,000,000, is situated on the Menam River, approximately 20 miles from the Gulf of Siam. The centre of the city, on the eastern bank, is surrounded by a wall 30-ft. high and from 10-ft. to 12-ft. thick, but the rest of the town stretches irregularly along each side of the river and covers in all an area of about 10 sq. miles.

The Kingdom of Siam lies between Burma on the west and French Indo-China on the east and has an area of 200,234 sq. miles. The great natural and economic centre of the country is the delta of the Menam or Mellam River which is annually flooded between June and November, the inundations covering several thousand square miles. The lower part of the river runs through a vast alluvial plain which is exceedingly fertile and is intersected by a great network of irrigation canals. It is one of the largest rice-producing areas in the world.

As a result of the progressive outlook of the Siamese Government, Bangkok is passing through a process of modernisation, and an instructive article, by Mr. C. M. Olesen, giving details of the past history of the town and harbour and the evolution and construction of the present port, which was completed as recently as 1942, will be found on a following page.

Visitors to Bangkok have remarked upon the striking appearance of the town. It is intersected by innumerable little canals which, with the Buddhist temples rising aloft in their dazzling and exquisite colouring render the city one of the most picturesque in the East. Many of the houses are built upon rafts, a single raft often having as many as 8 or 10 houses upon it, and the Oriental appearance of the city as a whole is in strange contrast with the modern innovations which have been introduced from abroad.

Storm Surges.

One of the worries of the navigator and the harbour master is the effect of the wind on water levels. Not only does wind cause waves whose length is related to the velocity of the wind and the periodicity of gusts, but the prolonged action of a more or less steady wind acting over a large sea area drags the whole sea into a slope usually towards the wind. This is due to friction of the wind on the water. Except in a most general manner this is often considered to be unpredictable, but in an article by Mr. Corkan, the Deputy Director of the Liverpool Tidal Institute, published in this issue, it is shown that a very fair estimate may be made of the rise or fall of the sea if the distribution of air pressure over the pertinent sea areas is known. The North Sea is particularly subject to wind effects, as is very well known by navigators to or from Hamburg. In 1936 Dr. Lueders published in the "Bautechnik" an article on the "Storm Floods of the North Sea in the Jade," which showed that wind lifts of one metre were common and that in heavy storms the wind lift might be over three metres. In the past these effects have caused disastrous floods in that part of Western Germany which adjoins Holland, and the surges which caused trouble in the Thames in 1928 will be remembered by many. The surge effects are greatest in shallow seas so that British east coast ports are specially interested. Fortunately, as far as this country is concerned, prevalent winds are in the south-west, so that the ports in question are not so seriously affected as on the Continent, but prolonged easterly winds can occur, and in any case, ship-masters are concerned with lowering of the sea level as well as heightening, since the lowering may cause grounding on shoals or entrance bars. Every aid that can be given to mariners in fore-knowledge of natural conditions will ease their difficult lot and we must congratulate Dr. Doodson and Mr. Corkan on the success of their investigations into this complex subject.

The Sino-British Trade Agreement.

During the Autumn of last year, a visit was made to China by a British Parliamentary Goodwill Mission under the leadership of Lord Ammon, Chairman of the National Dock Labour Board, and at a Press Conference in Peiping, Lord Ammon is reported to have said that a Sino-British trade treaty is being delayed because of failure to agree on the question of permitting British shipping to use Chinese ports and inland waterways. In reply, Chinese officials stated that the importance of British commercial interests has been over-emphasised, and China is only adopting a policy similar to that of other nations with regard to her internal river navigation and her coastal shipping.

A short article by Lord Ammon appears on page 255 of this issue, and from this it appears that just prior to the Mission's return to this country, a more reasonable tone was beginning to pervade the Chinese press. It is therefore unfortunate that subsequent reports state that the Chinese Government has no intention of relaxing the ban already imposed against foreign shipping entering Chinese inland ports.

There is no doubt that many British firms which formerly were engaged in the Chinese trade are eager to resume their activities, but feel unable to do so while an arbitrary prohibition against foreign shipping remains in force. It is therefore to be hoped that wiser councils will prevail and that the misunderstandings on both sides will be removed so that a regular flow of trade that would prove to the mutual advantage of both countries may be resumed at the earliest possible moment.

Editorial Comments—*continued*

Customs' Examination of Passengers' Baggage.

Among the numerous formalities productive of delay and inconvenience to travellers on arrival at a port is the particularly troublesome procedure connected with the examination of their baggage by the Customs Authorities. Much irritation has been caused to visitors to this country from abroad, as well as to British nationals on return home, by the necessity of awaiting the removal from the ship's hold of a number of articles which have unavoidably become segregated on the voyage and by the subsequent detailed scrutiny for dutiable goods, however expeditiously performed, while the unfortunate passenger is chafing with impatience to proceed on his journey. Few of our readers who have travelled abroad have failed to undergo this annoying experience. The suggestion has been made that the delay might be curtailed, or even altogether avoided, if the Customs' examination were carried out while the vessel was still at sea and approaching the port of destination. Indeed, this procedure has been experimentally in force for a year or so by British Customs Authorities in connection with voyages of the *Queen Elizabeth* and *Queen Mary*. We understand that two Customs Preventive Officers and an Immigration Officer are carried on every voyage of these British liners. The success of the system in saving of time and inconvenience has led to a proposal for its extension to the transatlantic service generally, but the United States Customs and Immigration Authorities appear to have rejected it as impracticable on American vessels.

The reason alleged is that there is an acute shortage of staff in New York, which would not permit of sending men to sea for long periods. The examiners, it is pointed out, would be idle half their time, as their services would only be required on the West-bound Atlantic trip, whereas their attendance at sea would extend to at least a fortnight per trip. This, of course, entails uneconomical expense and waste of time, yet, as regards the comfort and convenience of passengers, it has much to commend it. British Customs officials have frankly admitted that the system had helped the British Customs staff to overcome lack of personnel and had eliminated the long queues of passengers which used to congregate on the piers at Southampton. This last feature is undoubtedly a factor of the highest importance in the encouragement and development of tourist traffic—its moral effect is very significant and cannot be unduly emphasised. This being so, it is to be hoped that the authorities concerned will find a speedy means of reconciling the conflicting views of British and American officials in the interests of the travelling public, who have been rather neglected in the past and treated, in this particular respect, with comparative indifference, though in other directions their comfort has been admirably studied.

Port Nationalisation Problems.

The delegation by the Transport Commission of certain of their rights and powers under the Transport Act to the Docks and Inland Waterways Executive is, as was pointed out in our last issue an evident indication of impending changes, probably of a drastic character, in port methods and practices, as also possibly in present systems of port administration. What these changes are likely to be it is difficult to forecast, especially in the absence of any hints or guidance from the Central Transport Authority, but one important matter which must engage attention, is the possibility of increasing the efficiency of British ports as a whole by the amalgamation of those which lie in close proximity to one another and in which the trading interests are largely the same, with the elimination of those adjacent minor ports which may be considered superfluous. It has often been urged that the ports on the coastline of Great Britain, numbering over 300, and of various degrees of size and importance, are far too numerous for the waterborne commerce of the country and that more efficient service would be attainable with a lesser number. In a Paper read before the Institute of Transport a few years before his death, Sir David Owen, then General Manager of the Port of London Authority, advocated a system of port grouping so as to bring under single administration those which lie on the banks of the same river, or estuary, or are closely adjacent on the coastline. How far this proposal would prove practicable depends largely on local conditions, but it is certainly a matter for detailed investigation and consideration. It has to be admitted that there would probably be opposition to the proposal where local prestige is at stake, but in the larger economic interests of the country this would have to be waived. The step would necessitate the co-operation of the Customs authorities and the readjustment of customs boundaries, but amalgamation in this respect need not involve insuperable difficulties.

One word of warning must be uttered. The intricacies of the present order of things are so considerable that the greatest discretion will be required, lest altering the existing structure should bring about the very evils which it is intended to avoid. It is to be regretted that the suggestion put forward in 1945 by the Dock and Harbour Authorities' Association was not acceptable to the Minister of Transport. The Association proposed the formation of an Advisory Council to assist the Minister in considering proposals affecting Port Administration throughout the country. The experienced advice such a body could give to the responsible Minister would be invaluable and it is to be hoped that it is not yet too late to utilise the concerted recommendations of a representative group of experts such as the Association could provide. In a recent article in *Lloyd's List* on The Future of British Ports, Sir John Anderson, Chairman of the Association, indicating some of the dangers ahead, wrote: "Without in any way seeking to pre-judge the matter, it can fairly be said that it will need much to convince shipowners and merchants that the existing administrations at the largest ports which have been built up on local requirements and experience, and have been evolved in some cases over the centuries, can be improved by the imposition of additional central or bureaucratic control." The warning is one to which very careful heed should be given.

Speeding Ship Turn-Round.

One of the first tasks of the new Executive will undoubtedly be to evolve methods for the speedier turn-round of shipping in ports. This is evidenced by the fact that preliminary enquiries into this urgent problem have already been set on foot at London and other leading ports. The stay of a ship in port is the essential crux of the situation, for it must be borne in mind that not only is expedition in the handling and dispatch of cargoes one of the fundamental requirements of British overseas trade, but also that from an economical point of view any unnecessary detention or delay of a vessel at the quayside is a source of loss to the shipowner and/or charterer. Considered as a temporary warehouse or store for cargo while it is awaiting shipment, dispersal or transport inland, the ship is an extremely expensive agency; it is only remunerative to its owner when engaged in its proper and normal function of ploughing the seas. Every hour spent in port means an unremunerative addition to running expenses and while a certain proportion of idle time is inevitable, this has to be reduced to a minimum if excessive overhead charges are to be avoided. The interest on capital, coupled with the care and upkeep of machinery while out of action, and the wages of skeleton crews, represents expense of sufficient magnitude to influence materially the financial success of a voyage. The dimensions of such debits vary considerably, but the cost of a single day in port for an ocean liner may easily run to a sum of four figures.

A considerable degree of expense is due to dilatory methods of handling cargo, a service which is generally confined to daylight hours. With a view to reducing the amount of idle time, a proposal has been made for the institution of night work, as in factories. This would involve the introduction of a system of shifts and much will depend on the attitude of the dock workers and stevedores as to whether the scheme can be made workable in general, for it has already been practised on occasion to deal with emergencies. So far the suggestion is limited to the discharge of ocean-going steamers in the docks of the Port of London Authority, but it is of wider application than the area of the Thames and any general adoption of the principle would have far-reaching results.

These are not the only matters to which the Docks and Inland Waterways Executive will have to give its careful attention. The problem of canal exploitation in this country is equally of prime importance. The question of port expansion and improvement and the capital expenditure involved is likewise of serious urgency seeing that the development of British overseas trade is dependent on a satisfactory solution.

BANGKOK HARBOUR

A Description of its Construction and Development

By CHR. MUNK OLESEN, B.Sc., C.E.

Geography

BANGKOK—since 1782 the capital of the Kingdom of Siam and the largest city in South-Eastern Asia—is picturesquely situated along the east bank of the winding Menam Chow Phya River, which discharges into the Gulf of Siam. It is approximately 805 nautical miles north of Singapore, 640 miles from Saigon and 1,470 miles from Hongkong. It will be seen from Fig. 1 that in relation to the world shipping lanes Bangkok lies off the direct routes through Singapore to Far Eastern waters and to Australia. It is, however, the "Terminus" for some shipping lines from Europe and from China and is irregularly visited by other lines. Being off the beaten track, only ships actually handling exports from and imports to Siam visit the port. No calls are made for purposes of provisioning, coaling, etc.

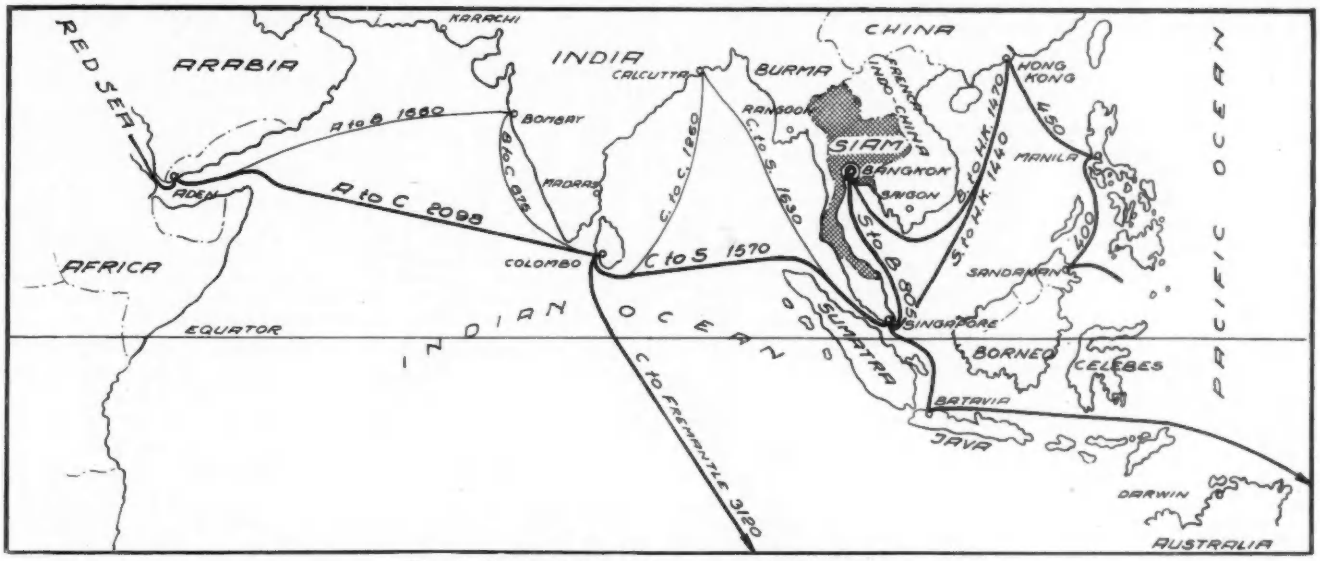


Fig. 1.—Bangkok in relation to World Trade Routes.

The Menam (meaning "river" in the Siamese language) is the natural gateway to Bangkok; prior to 1917 in fact, the only one. In that year the construction of the Bangkok-Singapore Railway linked Bangkok with Malaya and in 1926 a railway line was built up to the French Indo-Chinese border without, however, being extended into that country. These railways are mainly designed for passenger transport and most of Siam's imports and exports therefore still take place by ship. About 90% of Siam's trade passes through Bangkok. The other ports in Siam such as Bhuket, Pattani, Singora (or Sonkhla), Nakorn Sritamarat, Bandon and Kantang, are mainly of local importance. The Port of Bhuket on the west coast of the Malayan Peninsula forms an exception in so far as tin and rubber from south-western Siam are exported from there.

Roughly speaking, Siam consists of two parts, viz.:

(1) The long and narrow strip of territory along the Malayan Peninsula, approximately 700 miles long and varying from some 120 to only 10 miles in width.

(2) The more concentrated part of the country north of the Gulf of Siam, approximately 550 miles in both directions, where the majority of Siam's 17 million inhabitants live. The thickly-populated fertile Menam Valley, the central plain, is the heart of this part of the country. It is on all sides surrounded by mountains traversed by the tributaries to the Menam.

Siam's most important export—rice—originates from this area. Between one-and-a-half and two millions tons of rice was exported annually before the war, making Siam the second largest rice-exporting country in the world, surpassed only by Burma.

The Menam is the main artery of the valley and the all-important approach to Bangkok from interior Siam as well as from overseas. An irrigation system is in operation on the central plain, extending its canals down south of Bangkok almost to the Gulf Coast. Irrigation is necessary for the rice growers in Siam who usually can expect only half as big a rainfall as the farmers in Burma get. Moreover the Menam River is tidal as far up as Ayuthia. In Bangkok low water is 1.50 m. (5-ft.) below M.S.L. and highest water level combined with the December floods is 1.80 m. (6-ft.) above M.S.L. At several places the irrigation canals are linked up with the river and the tidal canals through locks.

From the Central Plain unhusked rice, paddy, is transported on the river and on the adjoining network of canals down to the numerous rice mills which line the river banks in Bangkok. The north-eastern part of the country, the Korat Plateau, which is separated from the Menam Valley by a range of mountains is not in water-way connection with Bangkok. Part of the paddy from this district is milled locally and the rice sent by rail to Bangkok. The export from the Korat Plateau alone amounted, before the war, to some 200,000 tons of paddy and 200,000 tons of rice annually.

The Menam and its tributaries also carry another major export article, viz.: teak, which grows on the mountain slopes around the upper reaches of the rivers. The teak logs are simply floated in rafts downstream to Bangkok's saw mills.

Statistics

Siam's overseas exports represented before World War II a value of just under Baht 200,000,000 per year with a peak in 1927-28 of Baht 270,000,000. (The pre-war value of the Baht was 1/10 or approximately 11 Baht to the pound. At present the official exchange rate is 40 Baht to the pound). The corresponding figures for the imports were approximately Baht 120,000,000 and Baht 200,000,000 respectively. As already mentioned, 90% of this trade passed through the Port of Bangkok.

The most important export is rice which in value represents approximately half of the above export figures. The weight of rice exported has varied considerably; from a minimum of approximately 1,000,000 tons in 1930-31 to a maximum of

Bangkok Harbour—continued

approximately 2,000,000 tons in 1934-35, falling off again to nearly 1,000,000 tons in 1937-38. Tne unit price, however, fluctuated in inverted proportion keeping the total value fairly constant between 80 and 100,000,000 Bant. Practically all of the export of rice was handled through Bangkok, only about 5% being divided between the smaller ports.

The rest of the pre-war export trade was made up of the following main items, besides smaller quan.ities of various other export articles:

Teak: From 2 to 3½ million cu. ft. annually representing a value of approximately 10,000,000 Baht. Practicaily all teak wood was exported from Bangkok.

Tin: Approximately 20,000 tons annually representing a value of some 30,000,000 Baht. Most of the tin was exported through harbours in South Siam.

Rubber: Approximately 35,000 tons annually representing a value of some 25,000,000 Baht. Rubber was mainly exported through harbours in South Siam.

Fish: Approximately 20,000 tons per year.

Salt: Approximately 100,000 tons per year.

The import trade mainly consists of manufactured articles such as cotton goods, machines, structural steel sections, fuel oils, tinned foodstuffs, tobacco, etc., totally 300,000 to 400,000 tons annually.

Tables I and II compiled from the Siamese statistical year book will give a clearer picture of the distribution of the various export and import articles divided up in groups according to the way they are handled in the harbour. It should be noted that the Siamese year is reckoned according to the Buddhist Era, and prior to 1941, the Siamese New Year was on the 1st of April. The year B.E. 2478, therefore, covers the period from April 1st, 1935 to March 31st, 1936. The tables refer to Bangkok only.

TABLE 1.—Imports to the Port of Bangkok.

year A.D.	1931/32	1932/33	1933/34	1934/35	1935/3
Description year B.E.	2474 tons	2475 tons	2476 tons	2477 tons	2478 tons
1.—Goods requiring shelter.					
(a) Sugar	19,500	46,900	40,500	44,800	66,400
(b) Cereals and flour ..	21,200	11,700	11,600	11,900	13,800
(c) Canned milk ...	4,700	5,300	6,100	7,500	8,900
(d) Cement	8,500	6,200	9,700	9,700	11,300
(e) Unprinted paper ...	4,300	5,500	4,000	7,500	6,000
(f) Sundry steel goods (not bars or similar) ...	15,800	12,900	16,100	20,600	21,300
(g) Textile manufactures	8,200	11,800	13,700	16,800	21,200
(h) Tobacco	2,200	2,100	1,900	2,100	2,100
(i) Gunny bags	59,400	27,100	30,000	16,600	43,000
(j) Sundries	15,900	24,600	20,900	33,800	35,400
	159,700	154,100	154.500	171,300	229,400
2.—Goods to be removed from the harbour area immediately upon arrival.					
(a) Fruits (not tinned)	5,800	5,100	4,300	5,200	5,500
(b) Vegetables	23,300	18,200	18,300	18,400	18,300
(c) Arms and ammunition	100	100	100	100	100
(d) Live animals ...	100	100	100	100	100
(e) Sundries (meat, eggs etc.)	900	700	700	800	800
	30,200	24,200	23,500	24,600	24,800
3.—Goods requiring open storage space.					
(a) Steel bars, sections etc.	20,700	21,600	23,800	23,600	37,900
(b) Coal and Coke ...	32,400	18,200	22,300	28.400	29,400
(c) Lubricating oil ...	500	600	400	600	600
(d) Various metals in rough	1,300	1,400	1,300	2,200	3,300
(e) Bricks, asbestos sheets, stone, wood, etc.	6,800	6,300	4,000	4,700	5,500
	61,700	47,100	51,800	59.500	76,700
4.—Goods to be stored outside the new harbour.					
(a) Benzine, Kerosene, liquid fuel	78,000	62,000	77,000	85,000	85,000
(b) Heavy machinery, etc.	1,000	2,000	5,000	4,000	5,000
	79,000	64,000	82,000	89,000	90,000
Total imports per year	330,600	289,400	311,800	344,400	420,900

TABLE II.—Exports from the Port of Bangkok.

year A.D.	1931-32	1932-33	1933-34	1934-35	1935-36
Description year B.E.	2474 tons	2475 tons	2476 tons	2477 tons	2478 tons
1.—Goods requiring godown space prior to shipment.					
(a) Rice, paddy ...	1,320,000	1,660,000	1,650,000	2,010,000	1,490,000
(b) Sticlac ...	600	300	4,000	8,000	5,000
(c Ducks eggs ...	300	1,000	1,000	3,000	3,000
(d) Sundries	24,400	25,500	25,900	31,200	35,000
	1,345,300	1,686,800	1,680,900	2,052,200	1,533,000
2.—Goods needing open storing space.					
a) Wood	64,000	57,200	64,300	61,000	59,000
(b) Ore	—	—	—	—	—
	64,000	57,200	64,300	61,000	59,000
3.—Goods requiring no godown space.					
(a) Fish	19,000	29,000	23,000	35,000	20,000
(b) Salt	80,000	77.000	93,000	132,000	121,000
(c) Fruits	4,000	4,000	4,000	4,000	3,000
	103,000	110,000	120,000	171,000	144,000
Total	1,512,300	1,854,000	1,865,200	2,284,200	1,736,000

Note.—All export of bark, betelnut, copra, damar, yang-oil, rubber, tin and wolfram ore, and firewood, is not included above, as these items are mostly exported via other harbours. On the other hand, all the export of rice and fish has been included above in spite of the fact that a small part is being exported via other harbours.

The principal countries to which Siam's pre-war exports were shippea were in the order of importance: Malaya, Hong Kong, the West Indies, India, Japan and the United Kingdom. From the first two-mentioned countries, however, much of the goods received from Bangkok were transhipped to other ports.

Just over eleven hundred ships and approximately 300 junks caiied annually at Bangkok. The largest of the regular overseas vessels which entered the river were the East Asiatic Company's ships of 5,000 to 7,000 B.R.T. drawing 24-28ft. Loading to this draft could, however, not be done in Bangkok, but required, to a certain extent, transhipment at Koh Si Chang, as it will be explained later on. The coasters ranged from 500 to 2,000 B.R.T. with some 12-15ft. draft.

Development of the Harbour Scheme

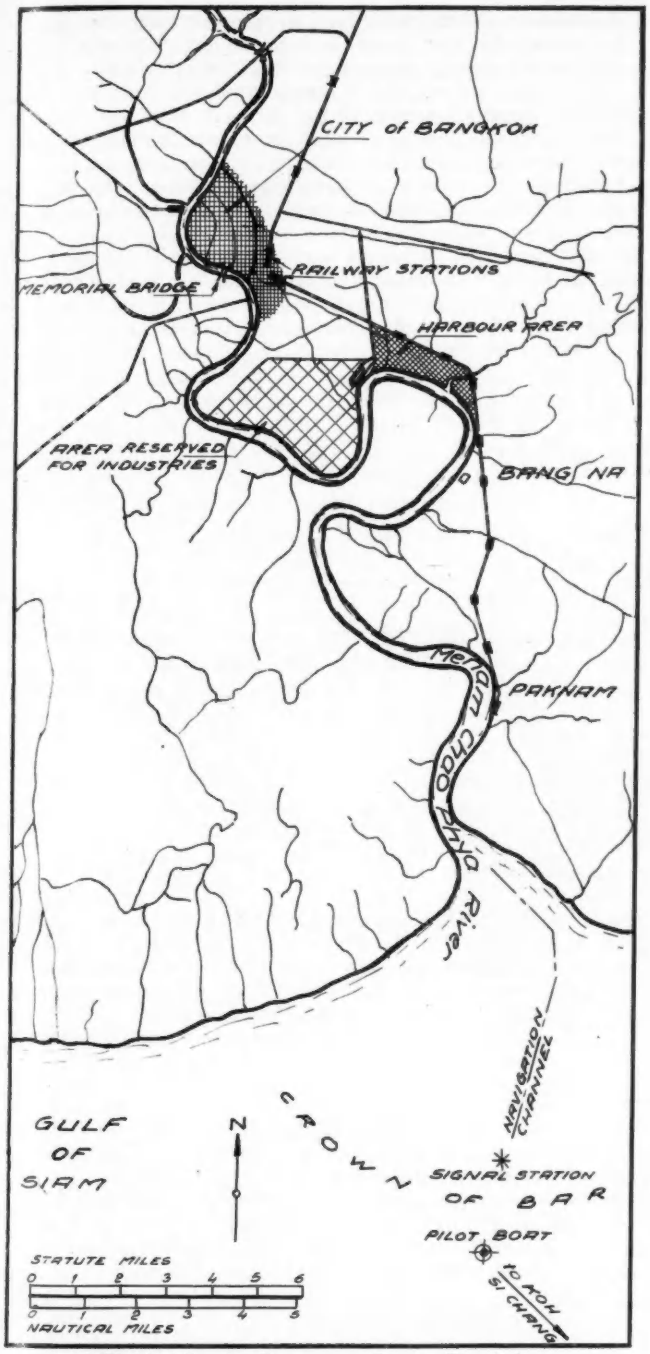
Bangkok of to-day is a city of just under one million inhabitants. In 1782 when it was made the Capital of the Kingdom after the previous Capital, Ayuthia, had been extensively destroyed during a war with the Burmese, it was only an insignificant village situated on the west bank of the river, opposite the present city. On the place of the old village is now the Suburb Dhonburi. Since 1782 and especially during the last 50 years a modern town has been built up where trade and industries on European lines are carried on among the glittering spires and towers of some of the finest masterpieces of ancient oriental temple architecture.

However, until the completion of the projects described in this article, i.e., until 1942, Bangkok did not possess a real harbour owned and operated by the Government with proper mechanical services. Nevertheless, large volumes of exports and imports were handled by ships' own gear. The overseas vessels and the coasters either anchored mid-stream in the river where they loaded from and discharged into small cargo boats, or they moored alongside the few privately-owned wharfs built by the large trading companies, such as for instance, The East Asiatic Company, The Borneo Company, The Bombay Burma Trading Corporation, The Anglo-Siam Trading Corporation, Mitsui and local shipping companies and oil companies.

The river provides an excellent anchorage, the depth at mean sea level ranging from 30 to 40-ft. and ample width is available for swinging with the change of tide.

Most of the private wharves are rather flimsy structures consisting of a timber deck on wooden piles. The piles are generally

Bangkok Harbour—*continued*



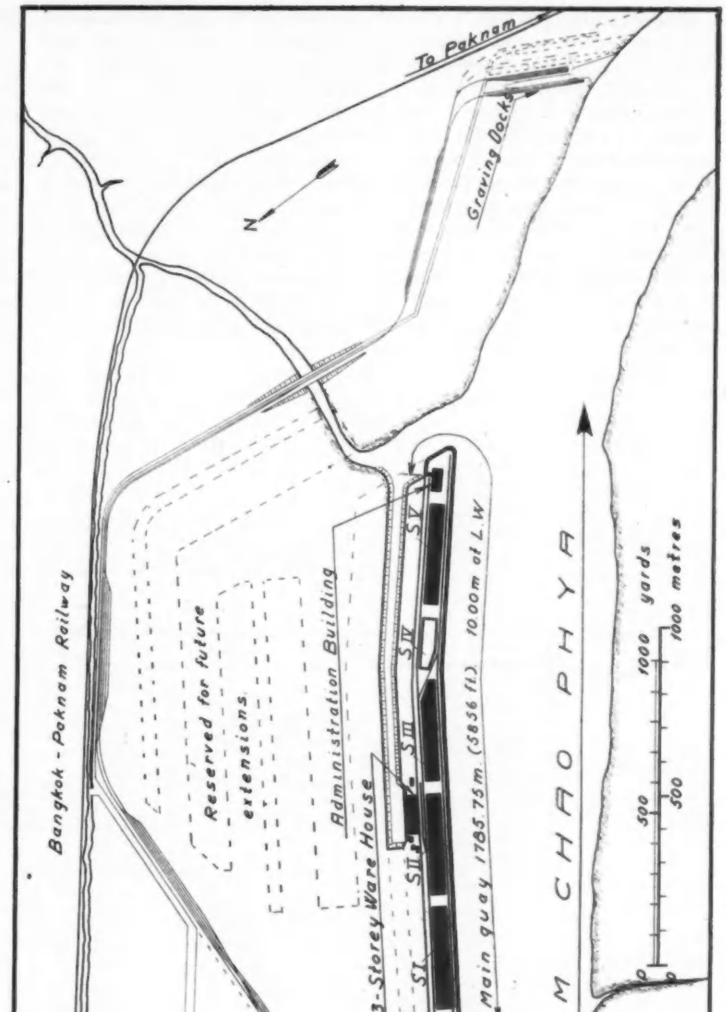


Fig. 2 (above).—Sea approaches to Bangkok.
Fig. 3 (right).—General Layout of Harbour Area.

encased in concrete as a protection against the ever-present teredos. In spite of their primitive appearance these wharves accommodated ships of 5,000 to 7,000 B.R.T.

Beyond the large bascule bridge constructed in 1932 by Dorman, Long & Co., Ltd., and partly destroyed during World War II, is the Naval anchorage with two graving docks for torpedo boats. Two commercial graving docks, the larger measuring 112 m. x 15.55 m. with only 3.5 m. depth on the sill, are owned by the Bangkok Dock Company, Ltd., and can only accommodate coasters.

The few available installations for operating the harbour (quarantine station, pilot stations, customs and administration offices, etc.), were scattered over the whole length of the Menam extending through the city.

Bangkok Harbour—continued

Already after World War I it was evident that the operation of the harbour with the existing facilities was too cumbersome and expensive. The engineering works required for the design and construction of a major harbour starting practically from scratch were, however, considered too involved for the country's own engineers and in 1933 the League of Nations were invited to give a recommendation on the subject.

A commission was formed by the League of Nations consisting of Mr. A. T. Coode (England), Mr. G. P. Nijhoff (Holland), and Mr. P. H. Watier (France). The result of their investigations was submitted to the Siamese Government in 1934.

At this stage it must be remarked that the question of providing a modern harbour for Bangkok is closely linked up with the more difficult question of improving the access from the ocean into the river.

(1) Maintaining a sufficiently deep shipping channel through the bar by regular dredging. As sufficient depth for the immediate requirements was recommended 7.00 m. (23-ft.) at high water, later on dredged to 8.50 m. (28-ft.) and perhaps to an ultimate depth of 9.50 to 10 m. (31 to 33-ft.).

(2) Dredging a canal from a point somewhere behind the river mouth and communicating through locks with the sea.

(3) Avoiding the problem altogether by building a harbour at some distance from Bangkok direct on the coast away from the bar and connecting this harbour with Bangkok by rail.

The first-mentioned procedure was recommended by the Commission as the best solution and was adopted by the Siamese Government. It was furthermore recommended to build at once 1,000 m. quay along the river bank near Bangkok.

Two years later, in 1936, after having studied the League of

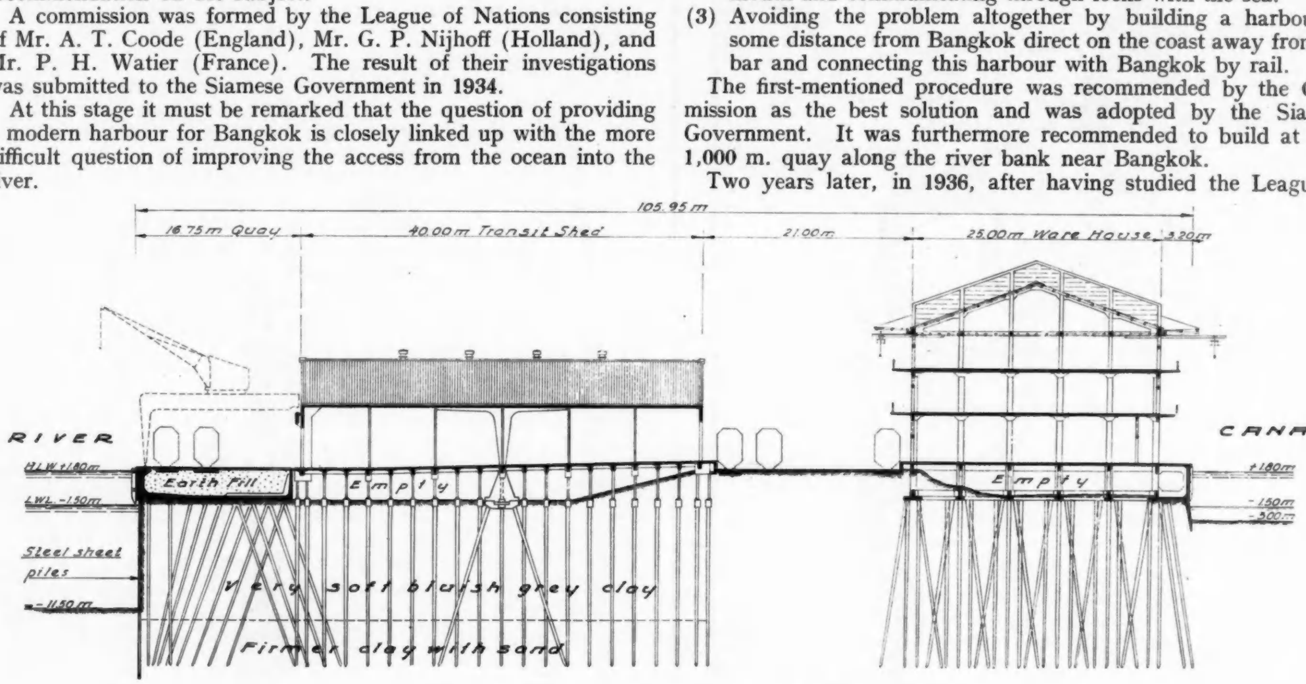


Fig. 4.—General cross-section of completed Pier.

The Menam, like most other rivers in tropical Asia, is heavily laden with silt and detritus and at the point where the river discharges into the Gulf of Siam, the velocity is reduced to such an extent that it drops most of the transported material. Through the years a bar has been built up roughly in a semi-circle with the river mouth as centre and a crown radius of some 6 to 8 miles. Incidentally, the whole central plain has, in the opinion of some geologists, been built up by the rivers. Sand deposits which are not very old, geologically speaking, have been found at several places in the valley indicating that in earlier times the bar and the river mouth have been far inland. Nature maintains a channel through the bar which allows ships of up to 13-ft. or 14-ft. draught to pass at ordinary high water.

In order to allow bigger ships into the river it is an old-established practice that such ships anchor up at the Island of Koh Si Chang, which together with some smaller islands provide a sheltered anchorage 19 miles south-east of the bar. Cargo is there transferred to lighters until the draught of the ship is reduced sufficiently to allow the ship to cross the bar at high water. For exports goods the reversed procedure is used. A special wharf for handling transhipment of petrol was built before the war at one of the smaller islands in the same group, called Koh Prong. The wharf consisted of three dolphins arranged on a line with a pipe connection from three steel storage tanks on the island to the centre dolphin. Tankers with up to 10-ft. draught could go alongside the dolphins and discharge into the storage tanks. Later on the petrol was taken to Bangkok in the Government's 2,000-tons tanker.

The whole transhipment procedure is, however, extremely expensive and time wasting and moreover it gives rise to various indirect expenses and losses, altogether estimated in 1934 by the League of Nations' Commission to cost the Siamese trade 8,750,000 Bahts per year.

The Commission examined in detail 3 possible ways of improving the access to Bangkok, viz.:

Nations' report and selected sites for the harbour itself as well as for the industries which the Government contemplated gradually to establish, or remove to areas adjacent to the harbour area, the Government invited civil engineering firms to submit proposals for a prize contest. The contestants should propose a general layout of the harbour, comprising arrangement of deep-water quays for the ocean-going vessels, shallow water quays for the river cargo boats, transit sheds, warehouses, silos, railway lines, roads and other specified constructions.

Furthermore, suggestions should be made for suitable mechanical equipment to handle the loading, transhipment and storing of all categories of exports and imports between overseas vessels and all inland means of transport by rail, road and river.

Nine proposals were received in September, 1937, of English, Danish, German, French, Siamese, Italian and Japanese origin. A prize of Baht 2,000 was awarded to each of four companies, viz.:

Christiani & Nielsen (Siam), Ltd.,
Hamburg-Thai Company, Bangkok,
Mitsui Bussan Kaisha,
Toed Chang, Siam.

Superficially these proposals were on very similar lines. The selected harbour area followed a fairly straight river bank on the one side and was limited on the other side by the Bangkok-Paknam railway line which ran practically parallel to the river approximately 1,000 m. behind the bank. The location of this site was excellent in several ways. While the centre of the city (say, the main railway station) is approximately 15 miles from the river mouth, as the crow flies, the sailing distance along the river is 28 miles. The new harbour avoids one large turn of the river and is only 17 miles sailing distance from the river mouth. At the same time it is only 4 miles by a straight road from the centre of the town. Fig. 2 illustrates these facts and shows at the same time the areas laid out for the contemplated new industries and the removal of old industries to the close proximity of the harbour

Bangkok Harbour—continued

area. One large industry was already built up here before the completion of the new harbour, namely, the oil refinery.

The natural layout of the new harbour was the deep water quay along the river with warehouses, railways and roads and a canal behind these structures for the river boats. Further deep water basins were envisaged behind the canal. In order to peruse the various solutions and draw up the final plans on which a tender for the actual construction works could be based, the Siamese Government engaged a well-known harbour expert, Professor Dr. Ing. A. Agatz.

In March, 1938, tenders were called for the first 1,860 m. of quay wall designed for an ultimate water depth of 10 m. (33-ft.) at low water. The tenderers themselves should submit detailed design and statical calculations of the type of quay wall they would suggest.

The tender and design of Christiani & Nielsen (Siam), Ltd., was accepted and a contract signed during July, 1938, and later on the same firm was entrusted with construction of transit sheds and other structures in the harbour. By the time Siam became involved in the war in the Pacific, the following constructions had been completed:

1,786 m	(5,850-ft.) of the Main Quay designed for 10 m. (33-ft.) of water at low water, but so far only dredged to 6 m. (20-ft.) at low water.
176 m	(577-ft.) of Quay on 1.5 m. (5-ft.) water depth at L.W. for motor boats.
2	Single-storey transit sheds 300 m. long x 40 m. wide.
2	Single-storey transit sheds 300 m. long x 32 m. wide.
1	Three-storied warehouse 120 m. x 25 m. with 150 m. of 1.5 m. deep quay at L.W. in front for river cargo boats.
1	Three-storied administration office 63 m. x 21 m.
45,000 m²	(54,000 sq. yds.) reinforced concrete pavement on the wharf and behind the transit sheds in the full length of the quay.

Fig. 3 shows the general arrangement of these constructions as they were actually carried out. The constructional features will be dealt with later on.

As to dredging a channel through the bar the Siamese Government had purchased a dredger with cutter suction equipment and begun dredging, but during the war in the Far East the dredging work had to cease.

Structural Details

When the layout was decided upon and tenders called for the design and construction of the first stage of the harbour scheme, the engineers were met with some rather puzzling problems, the chief one of which was, whether it was at all possible to build a sufficiently solid quay for 10 m. water depth at L.W. in Bangkok's soft underground and only after thorough examinations of the ground and after quite new theories had been evolved for the elastic properties of a quay wall in this particular soil, were the engineers satisfied that they had a safe design.

At Bangkok, as in fact most of the Menam Valley, the underground consists of pure blue-grey clay down to a considerable depth. The usual Rankine formulas which are based on granular backfill would only give deceptive results in this case. The clay, has, however, a certain cohesion and for smaller constructions an allowable shearing strength of 1 ton per sq. m. has usually been allowed. Most of the earth retaining structures previously built along the river were small bundings of seldom more than 2-3-metres depth of water. At the construction of one of the formerly-mentioned Navy graving docks, it was found that when excavations were carried out there appeared to be a "critical depth" of approximately 5 m. below ground level where the earth started a plastic flow into the excavation. For the new harbour, however, it was a question of 10 m. below L.W. The L.W. was at 1.50 m. below M.S.L., and the top of the quay was to be 2.24 m. above M.S.L. The total height of the quay wall would thus amount to $10.00+1.50+2.24=13.74$ m. or 45-ft. 6-in. Furthermore, live loads of 2 tons per sq. m. on the quay area and 3 tons per sq. m. on the floors of the transit sheds were specified.

In a depth of about 12 m. below M.S.L. the clay turned harder and thin layers of sand were also discovered in this level. Extensive soil investigations showed that for the deeper layers it would be permissible to use an allowable shearing strength of 3 tons per sq. m.

It is interesting to note the uniformity of both the top layer and the deeper layers. During the years 1937-38 Christiani & Nielsen (Siam), Ltd., constructed 50 road bridges for the new road from Bangkok to the town of Lopburi, approximately 90 miles north of Bangkok. For some of these bridges pile foundations were required. The Company had also constructed several pile foundations in Bangkok (e.g., the Navy graving dock referred to above) and also between Bangkok and the sea. At Saraburi, 65 miles north of Bangkok it was found that hard ground was available in a depth of only some 5 m. under the surface and it actually proved possible to use linear interpolation for determining the pile lengths anywhere inside these 65 miles and even to some extent, to extrapolate between Bangkok and the sea.

Fig. 5.—Transit Sheds under construction.

The hard sand and clay layers, however, were too thin to provide a reliable foundation layer for a heavy quay. Although it was possible to obtain a reasonable carrying capacity on single piles, calculations of the stability assuming circular failure lines showed that with 45-ft. height of the wall and 2-3 tons load on the ground, it was practically impossible to obtain stability.

One solution was apparently possible, however, namely, the one which is usually employed under similar conditions in most tropical river estuaries, the open wharf construction. At this type of wharf, the river bank is left in its original state and a sufficient number of reinforced concrete piles are driven, to carry a deck from dry land so far into the river that the required depth is obtained.

Such a suggestion was actually put forward but had to be dropped for several reasons.

In the first place, the constructions would have to be carried very far out into the river to obtain a 10 m. depth of water or otherwise a new slope would have to be dredged into the present riverbank. Such dredging, however, may easily disturb the natural flow of the river and give rise to scour into the embankment. Furthermore,

Bangkok Harbour—*continued*

such a design proved expensive due to the large number of concrete piles involved. The stability was doubtful and the open wharf construction is rather susceptible to bumps from ships. Calculations actually showed that the specified impact could not be absorbed without an excessive number of piles.

Fig. 6.—Completed Three-storey Warehouse.

Finally, a satisfactory solution was found, namely, the one shown on Fig. 4.

It is a comparatively light construction consisting of a steel sheet wall carrying, together with a number of inclined wooden piles, an earth-filled reinforced concrete box on which the R.C. Quay pavement is laid out. Behind the quay follows a 40 m. wide transit shed. To the right in the section is a 3-storied warehouse with a bunding towards the canal providing 1.5 m. (5-ft.) water depth at L.W., railway tracks and roads are arranged between the two lines of buildings. Characteristic for the section is the consistency with which the sheet wall is protected against all horizontal pressures which would otherwise be set up by the heavy super-loading and by the weight of the earth above M.S.L. The earth-filled "box" is now a quite common construction, but besides it will be noticed that under the buildings, earth has been removed to the greatest possible extent and the load from the buildings carried direct to the harder layers through separate pile foundations in order to lighten the construction. Even the shallow bunding along the 3-storied warehouse is suspended as a curtain from, and fixed into the foundations of the warehouse, independent of support from the soil. Practically the only area carried direct by the ground is the road area between the building on which no considerable live load is envisaged.

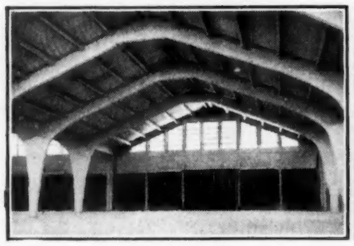


Fig. 7.—Interior of Transit Shed.

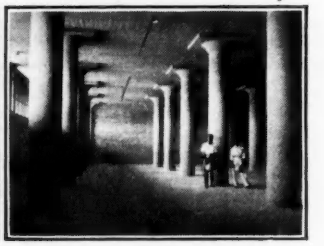


Fig. 8.—Interior of Three-Storey Warehouse.

Even then the calculations proved a difficult problem. It is sufficient to say that during this operation quite new theories were developed, based on the relation between the internal stresses in the soil and the elastic properties of the clay, sheet piles and wooden piles acting together as a whole.

In the calculations, due regard was taken to the fact that the stresses would be developed gradually during the dredging in front of the finished quay. Prior to the dredging no stresses will occur in the ground, but during the dredging internal stresses will develop and horizontal deflections will take place. Differential equations of the fourth order can be set up, expressing the relation between the stress distribution and the deflection curve. The system is several times statically indeterminate, but with the help of approximations the equations were solved and the dimensions which were found in this way appeared very reasonable.

In this connection, it must be explained that the front of the quay followed pretty close to the river bank at high water so that the entire construction took place on dry land.

As previously mentioned, wooden piles were used to a great extent, mainly where the piles are surrounded by earth and always below the ground water table. Under the sheds concrete extensions were made for the part of the piles which was exposed to water.

Altogether 22,000 wooden piles and 4,500 steel sheet piles were driven. In order to absorb the large horizontal forces acting on the sheet wall it was necessary to use in some places piles driven with a rake of up to 1 : 2¾.

Expansion and contraction joints were made every 100 m. in the shed floors and closure joints were arranged for every 33⅓ m. in the concrete parts of the quay. Special provisions were also made for dewatering the empty rooms under the sheds through pipes with one-way flap gates. Cast steel bollards were provided for every 33⅓ m.

The transit sheds are single-storied buildings of fully fireproof design. The carrying structure consists of two hinged reinforced concrete frames of 20 m. span. In order to allow the expansion of the shed to follow that of the floor, special reinforced concrete trusses with tie rods are provided in some panels without however, breaking the pleasant uniform appearance of the frames. The roof is corrugated asbestos on reinforced concrete purlins. The floor slopes from ground level at the front of the sheds to an 80 cm. higher level at the back of the sheds, corresponding to the floor level of the railway trucks. The largest door openings are 5.00 m. wide and 5.50 m. high.

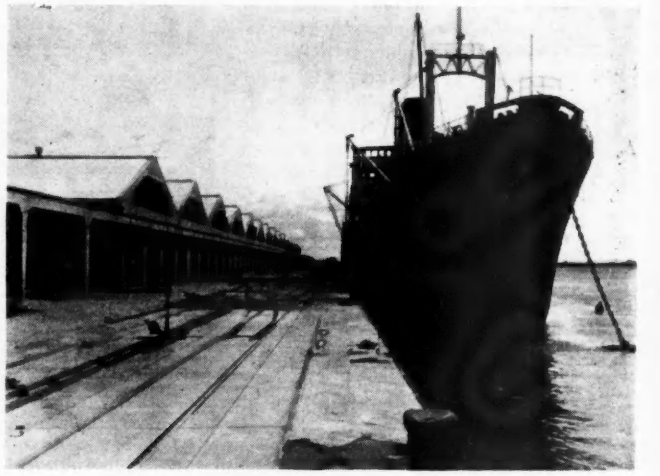


Fig. 9.—Ship alongside completed Quay.

The three-storied warehouse is a 2-way reinforced flat slab construction also built of fireproof materials throughout. At the design of all buildings it has been endeavoured to create the best possible working conditions compatible with a tropical climate, particularly by providing to the greatest extent, shade against the sun and shelter against the torrential rains.

All buildings are built in a similar style so as to match each other, the predominant feature being reinforced concrete framed constructions with unplastered red brick filling.

All roads are paved with reinforced concrete also between the rails which are laid out on separate reinforced concrete slabs.

The total quantity of concrete (not including the superstructure of the buildings) is approximately 70,000 cub. yds. Nearly 400,000 cub. yds. of earth was moved.

Bangkok Harbour—continued

The remaining figures (Nos. 5 to 9) show different views of the buildings during construction and after completion.

As far as the mechanical equipment is concerned, the war has interrupted the delivery of this part of the development scheme. To serve the quay, cranes of 3-ton capacity were envisaged running on one rail at the quay front and another rail along the roof of the transit sheds. To serve the 3-storied warehouse, hoists of up to 1-ton capacity were planned and elaborate stacking machinery was intended for all buildings.

At present only a water depth of 6 m. corresponding to the first stage of the development has been established on half the length of the quay. Until a greater depth can be maintained on the bar, this depth is sufficient. The dredging works on the bar have also been held up by the war, but it will probably not be long before this important work can be continued.

The general plans have been worked out and the construction works supervised by the Ministry of Economic Affaires under the direction of H. E. Phra Boribhandh Yuddhakich. As previously mentioned, Prof. Dr. Ing. A. Agatz was engaged by the Ministry as technical adviser. He was assisted by Chief Engineers Luang Prasert Vithirath and Mr. A. D. Schwatke.

The civil engineering construction works were entrusted to Christiani & Nielsen (Siam), Ltd., according to a detailed design worked out jointly by them and the Harbour Committee's technical adviser. On the Company's part, the design and construction works were carried out under the direction of the Company's manager, Mr. A. Kann Rasmussen, B.Sc., C.E., assisted by the Christiani & Nielsen Concern's Central Drawing Office in Copenhagen and by the author who was also inspecting engineer at the construction works. Phra Prakob Yantrakich, M.Sc., C.E., was resident engineer and Mr. P. Y. Chu, B.Sc., C.E., was job superintendent. Professor A. E. Bretting, who up to 1940, was the chief engineer of the Christiani & Nielsen Concern's Central Designing Office in Copenhagen, developed the new theories on which the calculation of the main quay was based.

China's Waterways and Inland Ports

Ban Against Foreign Shipping is Detrimental

By THE RIGHT HON. LORD AMMON, P.C., D.L., J.P.
(Chairman, National Dock Labour Board).

During my recent visit to China as a member of the British Parliamentary Goodwill Mission, when invited to address a gathering of the Sino-British Cultural Association, or other assembly in which British people predominated, it was not difficult to point out that at the present juncture, Britain was not in a position to afford material aid to China. In defence of liberty—not for ourselves alone—Britain had spent her reserves and pledged the national credit so that the links in the chain of trade and commerce were for the time being broken. There was also the devastation of the war to be made good in the homeland, and our people were facing this herculean task with courage and determination. Ideas and ideals, in the long run, proved better and more enduring ties between peoples than force and material possessions. In this Britain and China, given the will and a common purpose, could shorten the time in which to overcome difficulties; together they could do much to maintain peace in the world.

In reply to a question by a reporter at a Press Conference in Peiping as to how best a start could be made to achieve such ends, I said: by trade and commerce—that is, the exchange between nations of goods and materials to meet essential needs; and that the opening of Chinese waterways to foreign shipping was an obvious first step.

In reply to further questioning as to whether Britain allowed foreign shipping to enter her ports and inland waters, I replied: "Certainly! Any ship flying the flag of another country can proceed up the Thames right into the heart of London, or even on the Manchester Ship Canal—an artificial waterway."

I went on to say it was no part of my Government's business or mine to tell China how to organise her own affairs; but having been asked a question I gave, as I saw it, an honest reply.

A Chinese pressman asked why British ships should be allowed to sail in Chinese waters? The reply was: firstly, China has not sufficient to carry on the traffic; secondly, Britain has had many decades of experience in such traffic; and thirdly, the cost of double handling by the loading and unloading of ships at Chinese coastal points was prohibitive to business.

Not unnaturally, a wave of excessive nationalism is reflected in the closing of the Yangtse to foreign shipping and the application of a too rigid import licence system. Therefore, it was not a matter for surprise that some of my answers to questions were misunderstood, and the Mission had a "mixed press" on this subject. But before we left China there were more favourable comments, both in the press and in conversation.

On November 6th, the independent Chinese-owned "China Press" came out in support in an editorial. "Such an arrangement," the paper said, "temporarily, if necessary, would be of advantage not only to foreign shipping, but to business as a whole, since it would reduce the freight rates from up-river centres, thereby aiding China's export effort. The gain to British shipping, for a long time the chief carriers of freight along the Yangtse, should be obvious. But the gain to China's national economy as a whole should be even more obvious. We believe in this case the point has nothing to do with national sovereignty."

Later, on November 29th, 1947, the "Shanghai Evening Post," under the heading "China's Shipping Mess," entered the field more vigorously and, in an editorial, said: "The facts are well known . . . . and thoroughly apparent in an interior where potential export cargo lies rotting. China's whole economy is, in fact, adversely affected. Food for Chinese starving was denied the needy by the successful frustration of attempts to let U.N.R.R.A. cargo be taken directly up to inland ports, when physically possible, rather than be subjected to costly transhipping in order that Chinese shipping firms might be favoured. It would serve China's best interests if the Government were voluntarily to ask even that foreign firms temporarily resume interport runs until such time as Chinese shipping has grown up to the urgent needs. British shipping has been of tremendous benefit to China in the past."

It is tragic to see the idle and empty wharves and warehouses on the various waterfronts and to know of the clamant need for the employment of the tens of thousands of a hard-working, industrious people; to let matters drift and so make more difficult the return to social and economic stability. What is needed urgently at present for Chinese rehabilitation is the free movement of goods in China and on rivers, and if British ships can do the job economically and conveniently, then it is to the advantage of China and the Chinese. For the time being at least, permission for foreign ships to navigate Chinese rivers means quicker rehabilitation and acceleration of mobilisation measures.

In 1747 the Emperor Chien Lung sent to King George III, by Lord Macartney (the leader of a British Mission) a letter in which he said: "We possess all things: we are not interested in strange and costly objects and we have no use for your country's products." In the same letter he also wrote: "Your ambassador asks us to allow your ships to trade at other ports beside Canton; this request is refused."

It is difficult to believe that there are to-day in China people in responsible positions who would put back the clock 200 years. Many of China's best sons and daughters have travelled during the intervening years, far beyond the Great Wall. Many have studied in British schools and universities and know that no nation, however big and whatever its internal resources, can live to itself alone and that any attempt to do so will, in the long run, excite feelings and emotions bound to upset the peace of the world.

This surely is the time when those nations which by past association, co-operation and mutual suffering, and whose aims and ideals are for the dissemination of peace, should, whilst each maintaining its national integrity, seek the way of understanding and united endeavour.

PORT OPERATION

Part 14 of a Series of articles by A. H. J. BOWN, M.Inst.T., A.C.I.S., and Lt.-Col. C. A. DOVE, M.B.E., M.Inst.T.

(Continued from page 240)

The Agent's Work

The port operator's work in connection with discharging and loading vessels is closely associated with the duties carried out by the steamship agent. A brief summary of the agent's work is therefore inserted here.

The agent is the appointed representative of the shipowner, and the master relies completely upon him at any port of call. In ports where the shipowner has his own head office or branch office, the work which would otherwise be done by an agent is often carried out by the owners' ship management or agency department.

When the agent receives the first news of a ship to arrive (on an approximate date) for his agency, he normally advises the port authority, the Customs Waterguard, the Port Health Authority, the Pilotage Authority, a firm of tug owners, and a firm of stevedores. There are ports where the port authority controls more than one of the functions represented in this list: and in such cases, the agent has fewer people to advise.

The agent will give the master every assistance in complying with all H.M. Customs regulations for " clearing his ship." The following matters and documents must be dealt with:—

(1) **Pratique.**

Handed to master by Customs officials who board ship on arrival. It is the ship's health certificate: and is issued only if there is no infectious disease on board. Neither passengers nor crew may land pending issue of Pratique.

(2) **Inward pilotage.**

If an incoming vessel takes a pilot, before leaving the ship the pilot hands the master a signed card giving particulars of the job done. The master and agent lodge the card with the pilotage authority, pay the charges and (at some Ports) the pilot ruler signs the masters Report (see below), accordingly.

(3) **Jerque note.**

Customs officers board every vessel inward bound from foreign parts and search her for hidden contraband. The master produces to the Customs officers a list of dutiable goods declared to be in possession of each member of the crew. Small quantities for personal use are allowed duty free, but proper charges are collected on any other. The master is given a certificate of clearance inwards after bonded ship's stores remaining on board have been checked with the Report (see below) and sealed up by the Customs. They are checked again and re-sealed after discharge of cargo. After this resealing and production of the B.B. Form (see below), the Customs officers hand the master a Jerque note, in duplicate. One copy goes to the Customs House before the ship can get an outward clearance; the ship keeps the other.

(4) **Report (in duplicate).**

To be signed by the master and delivered to H.M. Customs at the port of arrival. Particulars: Details of ship, cargo, master, port of origin, present berth, dutiable stores on board, cargo intended for other ports, number and nationality of passengers, agent, and a declaration of " not breaking bulk " (delivering goods out of the ship) since leaving port of origin.

(5) **Parcels list.**

To be lodged with H.M. Customs. Particulars: Any small consignments on board not shipped on B/L's.

(6) **Mails Certificate.**

To be lodged with H.M. Customs. Declaration by master that all mail has been handed to postal authorities.

(7) **Tonnage dues inward.**

Paid by the agent to the Dues Collector of the port authority. This is the ship's payment for the shelter and accommodation provided by the port authority. Practice as to time of payment differs. At some places, the agent pays dues for regular British traders after their departure. The better rule is payment promptly after arrival; and there are ports where the Dues Collector stamps or signs the master's Report before he takes it to the Customs.

(8) **Light dues.**

Payable by the master (or agent) to the Customs who collect for Trinity House. In the foreign trade, a ship pays six times a year is then exempt. In the home trade, exemption is obtained after ten payments in a year. The payment is for upkeep of the coastal navigational aids maintained by Trinity House.

(9) **Passenger list.**

To be submitted first to the local Immigration Authorities for scrutiny, and if passed, to be then lodged with H.M. Customs. The list gives complete particulars of all passengers, with separate forms for aliens.

(10) **Ship's protest.**

Statement made and signed by the master before a notary public, upon arriving in a home port with cargo from foreign parts. It is a declaration made to protect the owners and master against possible future claims for damage to cargo. In ordinary cases the protest is in common form against wind and weather. In special cases full details of any misadventures are given. The master may extend (i.e., add to) the protest within six months.

(11) **B.B. Form.**

Handed to the master by the local superintendent, Ministry of Transport (Board of Trade) after signing-off crew. It certifies that the ship's articles (crew record) have been duly closed. The master will have to produce it again before signing-on crew (opening articles) for the next voyage.

(12) **Ship's certificate of Registry.**

To be produced to H.M. Customs and to the port authority when entering inwards.

(13) **Deck cargo certificate.**

Cargo stowed on deck or in any other unregistered space is measured up by H.M. Customs who certify accordingly. The Certificate must be produced to the port authority when tonnage dues are being paid.

(14) **Stores authority.**

Herein the master applies to H.M. Customs for permission to take aboard such bonded and dutiable stores as will be required for use at sea. The actual shipment is later supervised by a Customs officer.

(15) **Entry outwards form.**

From the master to H.M. Customs. Particulars: Destination and details of load-line.

(16) **Ballast declaration.**

From the master to H.M. Customs when no outward cargo is to be taken; it also contains a summary of the bonded stores to be shipped. As the different suppliers, in turn, pass their own Customs entries, the details are entered up on the Ballast Declaration by the Customs staff.

Port Operation—continued

Clearance Outwards

It will be seen that items numbered (14), (15), (16) and to some extent (3), above, are connected with clearance outwards, but, in practice, they are often dealt with for convenience sake when the master is at the Customs House clearing his ship inwards.

The complete list of items connected with clearance outwards is as follows:—

(1) Entry Outwards Form }
(2) Ballast Declaration } See above
(3) Jerque Note }

(4) **Master's Declaration and Stores Content for vessel outwards with cargo.**

Used for outward cargo vessels, instead of the Ballast Declaration mentioned above.

(5) **Tonnage dues.**

Dues on a vessel are occasionally chargeable outwards as well as inwards; at some ports, in certain circumstances, port dues are one way only and dock dues both ways; and again at places and for purposes where dues are charged one way only that one way is sometimes upon "clearing from the port." Dues tables vary considerably from port to port. In cases where there is an arrangement for the port authority to notify the Customs of the proper payment of tonnage dues, it is often done by the Collector of Dues signing the Master's Declaration.

(6) **Light dues.**

As in "Clearing inwards." The receipts for these payments should be retained by the master and attached to his ship's papers for future production to prove exemption.

(7) **Victualling Bill.**

Particulars of bonded and draw-back stores put on board; number of crew; whether any passengers; ship's destination. Draw-back stores are dutiable goods upon which duty has been paid and in respect of which a refund of duty is claimed because the goods have not been passed into home consumption.

(8) **Bills of Health.**

Issued to master by Customs or by the consulate of the country to which he is to sail. He must have one for every foreign port on his intended route.

(9) **Passenger lists.**

(a) A list must be made out for every port at which passengers are to disembark.

(b) Consular crew lists are required for vessels proceeding to the U.S.A. and to some other countries.

(c) A full passenger list must be made out, submitted to and signed by the Principal Searcher of the Customs and by the Emigrant Officer, and sent to the Ministry of Transport (Board of Trade).

(10) **"A.A." Form.**

Handed to master by Ministry of Transport (Board of Trade) when their official has satisfied himself that a new crew has been properly signed on.

(11) **Clearance Label.**

Obtained by master or agent from H.M. Customs. It bears the name of the ship and of the master and is fastened to the Victualling Bill.

The last act in the clearing of a ship outwards is the production of all the forms to the Principal Searcher at the Customs House. He will also want to see the ship's passenger certificate, if any. If he is satisfied he will seal, sign and stamp the Label.

(12) **Ship's manifest.**

The agent should supply a copy of the completed outward loading manifest to H.M. Customs (so that they may check off the passing of entries by the exporters) and a copy to the port authority (to enable them to check the payments of outward dues on goods).

Cargo for each proposed foreign port of discharge should be separately manifested, and each such manifest must be viséd by the appropriate Consul at the loading port, and placed with the ship's papers on board.

(13) **Ship's papers.**

It may be found useful to note here that the term "Ship's papers" normally includes:—

(a) The Certificate of Registry.
(b) The Articles.
(c) Load Line Certificate.
(d) Safety Radio Certificate.
(e) Deratisation Certificate.
(f) Copies of the charter party (if any) and the bills of lading.
(g) The Bill of Health
(h) Manifests, stowage plan and invoices of the cargo.
(i) The Official Log Book.
(j) The chief officer's or ship's log.
(k) The chief engineer's log.

Traffic Department Records

One valuable way of illustrating, in small compass, the character, limits and scope of traffic department administration and control is to bring together, in one list, the names of all forms and books of record in daily, periodical or occasional use. Such a list is set out hereunder. It relates to a system now in operation at a U.K. port of medium size with a mixed trade. The capital of the undertaking is about £2,500,000; the normal annual throughput is 5 million tons of coal outwards, 400,000 tons of general imports and 100,000 tons of general exports; the port authority operates its own railway system between the ship's side and the exchange sidings; the port authority also undertakes nearly all the stevedoring, sub-letting the work to approved stevedoring contractors. There are several large industrial tenancies on the docks estate and many smaller ones. The traffic manager has an office staff of 10 persons; he works in association with the Dockmaster and the Resident Engineer; and his principal outdoor assistants are one staithmaster, two general traffic foremen and one mechanical foreman. The traffic manager controls an outdoor weekly staff of about 150 persons—crane drivers, locomotive drivers, shunters, warehousemen, coal teemers, and similar categories. There are, in addition, about 220 registered port transport workers under the control of the National Dock Labour Board. The shore maintenance staff, controlled by the Resident Engineer, consists of about 260 tradesmen and labourers; whilst the floating staff is about 80 strong and is controlled by the Dredging Superintendent. The Resident Engineer and the Dredging Superintendent are responsible to the Chief Engineer; the Traffic Superintendent and the Dockmaster are responsible to the General Manager.

The Forms

The list which follows is divided into sections relating respectively to (1) Goods traffic (2) Coal (3) General and (4) Wages. In each case a brief indication is given as to where and when the document is made out, by whom, how often, and (where explanation is needed) its distribution and its purpose.

(1) Goods Traffic.

Manifest of outward cargo. Traffic Office. On completion of vessels. Sent to shipowner or agent.

Advice note (iron ore). Traffic Office. As wagons are loaded ex ship. Sent to consignees to enable them to prepare to off-load wagons at their private siding.

Declaration of Goods Shipped. Exporter's office. Monthly. Sent to Traffic Office. It gives details of goods and is an undertaking to pay all charges.

Declaration of Goods Imported. Importer's Office. Monthly. Sent to Traffic Office. As foregoing item.

Specification of timber despatched. Traffic Office. When timber has been measured and loaded up. Sent to importer to tell him what has been sent to whom.

Grain advice. Traffic Office. Similar to timber advice.

Goods advice. Traffic Office. Similar to timber and grain.

Goods weighed form. Weigh Cabin. Weigh clerk. After passing loaded wagons over weighbridge. Sent to Traffic Office. Used in compilation of monthly weighing and haulage accounts.

Port Operation—continued

Goods outward weighed sheets. Weigh cabin. Weigh clerk. Summary of the foregoing forms. Sent to Traffic Office.
Weight Certificate. Traffic Office. Signed by Traffic Manager. Supplied to trader on request at a tariff charge as authoritative evidence of the weight of a consignment.
Government Department Advice Note. Special forms supplied by Government Departments in connection with their imports from overseas. Department sends form, in quintuplicate, to their forwarding agents at the port. He send all five to Traffic Manager. He takes the goods from the ship and loads them to rail. He completes the forms (ship, goods, wagon numbers, date), sends one copy to the Department, one to the consignee, and three to the Railway Company. They retain one at station of origin, send the second to the destination station, and the third to the Department with their account of rail charges.
Consignment note. Supplied by Railway Company for use in Traffic Office. Particulars of goods and destination. Handed to Railway Company on despatch of goods.
Dock Warrant. Prepared in Traffic Office at request of owner of goods in store. Traffic Manager's signature certifies existence of goods in his custodianship. Warrant sent to owner—usually for purposes of hypothecation of goods. On issue of warrant the goods themselves and the ledger record must be "blocked" accordingly. Further deliveries only made upon production of warrant with assignments endorsed upon it.
Monthly list of imports and exports. Traffic Office. Sent to General Manager. Used in compilation of monthly trade report submitted to the Board of the port authority.

(2) **Coal.**

Railway Wagon Ticket. Colliery. Every wagon. Attached by colliery despatch staff. Wagon number, date of despatch, net weight and consignee (usually a ship's name). Removed at staith top by coal teemer before tipping wagon. Particulars entered by teemer in staith shipping record. Tickets collected by N.C.B. representative at end of shift.
Outshipped ticket. Staith top. Attached by teemer to any loaded wagons "shut-out" of originally intended steamer. Wagons placed in "light road" temporarily. "Outshipped ticket" reremoved when wagons are re-positioned upon receipt of fresh shipping instructions.
Declaration of shipments. Coal Office (sub-section of Traffic Office). Weekly. Sent to Railway Company on form supplied by them. Colliery, class of coal, wagon particulars—covering total shipment at dock staiths during the week.
Daily return of coal and coke shipments. Coal Office to General Manager. Vessels' names, collieries, quantities, loading times. Also used by Accountant for charging purposes.
Staith foremen's daily order sheet. Coal Office to staith foremen. Relates to vessels loading or about to load.
Particulars of wagons to come forward, bunkers, stowage in holds, classes of coal, collieries.
Staith foremen's shift report. Staith foremen to Traffic Manager. Log of work done during shift; vessels, quantities, stoppages with causes, special remarks.
Daily advice of coal required for shipment. From the Coal Office to the Railway Company at noon daily. Relates to vessels expected; details of cargoes to be lifted. Enables Railway Company to place empties at collieries concerned.
Coal teemer's daily sheet. Made out by chargeman and sent to Coal Office. Number of staith, vessel, teemers' names, date, working times, wagon numbers, weights.
Daily record of stoppages. Coal Office to General Manager, Traffic Manager and Railway Company.
Declaration of coal and coke shipped at the Port. From N.C.B. to port authority's Accountant who renders shipping charges accordingly after checking against Daily Returns from Coal Office.
Daily statement of vessels loading, quantities shipped to date, and vessels expected. From Coal Office to General Manager, Traffic Manager and Railway Company's Yardmaster.

(3) **General.**

Water supplied form. Made out in duplicate by port authority's water boatman on board vessel to which fresh water has been delivered; shows number of gallons and whether for tanks or boilers. Original Signed by ship's officer and sent in duplicate to Dues Collector, who hands the original to ship's agent when payment is made.
Materials requisition. Traffic Manager to Chief Engineer. Request for stores or repairs to working gear or facilities.
Stores delivery order. Traffic Manager to Resident Engineer. Request for working stores to be handed to messenger by Engineer's Storekeeper.
Materials received form. Traffic Manager to Accountant. Reporting particulars of working stores ordered and received from outside firms. Accountant uses these forms to check invoices.
Breakdown report. From Mechanical Foreman to Resident Engineer (for immediate delivery and action); copies to General Manager, Chief Engineer and Traffic Manager.
Daily List of all vessels working, repairing or fitting-out, and cargo vessels expected. Traffic Manager to General Manager; copy to Chief Commercial Assistant.
Cranage and labour requisition. Ship's agent to Traffic Manager. Request to load or discharge vessel, agreement to pay agreed or special rates, to pay any proper extras, and indemnify port authority against possible damage to cargo and other unforeseeable eventualities.
Crane requisition. From trader or tenant to Traffic Manager; order for crane and driver for a particular purpose; undertaking to pay proper charges and to indemnify port authority against all possible claims.
Abstract of traffic receipts. Monthly. Traffic Manager to Accountant. Cash analysis of total traffic charges for month. Columns for dues on goods, labourage charges, cranage, and the like—with comparative figure for corresponding month of previous year. Accountant journalises and posts to ledger accounts.
Traffic account form. Traffic Manager to trader; copy to Accountant; copy retained. General form for all charges; date, details, service, ship (if any), weight and rate per ton.
Accident Report form. From Traffic Manager or Engineer to General Manager. Particulars of workman concerned, rate of pay and details of injury. Information forwarded to Factories Inspector as necessary. If the man is incapacitated for 3 days, information sent to Insurance Company.
Compensation Supplementary Claim form. From injured workman, through Traffic Manager or Engineer, to General Manager. Rendered in duplicate. Full personal details of claimant, dependants, family and allowances. Both copies to Insurance Company; they forward one copy to Ministry of National Insurance.
Daily Requisition of Common User wagons. Daily at 10 a.m. from Traffic Manager to Railway Company's Yardmaster. The information relates to **to-morrow's** requirements for all purposes including dock tenants as well as for vessels working.

(4) **Pay System.**

Employee's Pay Slip. Weekly. From Accountant to every weekly employee. The slip is in two parts, a carbon copy from the Pay Roll and a copy of the Earnings Record Card. Rate, hours worked, gross wage, insurance and tax deductions, net wage and holiday credits.
Transport Workers list of earnings. This relates only to such registered port transport workers as are engaged direct by the port authority. (The main body of the registered men are engaged as required by one or other of the sub-contracting stevedoring firms). Names, numbers, gross earnings for week. From Traffic Manager to Accountant at noon on Saturdays.
List of week-end earnings. Separate form, dealt with as foregoing (relating to previous week-end).
Weekly statement of Transport Workers' wages. Traffic Manager to Accountant. Weekly. Summary of the two foregoing lists, brought to a total with Labour Board's percentage surcharge added. Accountant forwards the 3 forms to the Labour Board every Monday, simultaneously paying the total amount due to the Board into the Bank for the credit of their account.
Coal Teemers' Wages Sheet. Weekly. From Coal Office to Accountant.

(continued on page 259)

Port Operation—*continued*

Coal Shipping Staff Time Sheet. Weekly. From Coal Office to Accountant (covering Staith Foremen, Jetty Clerks and bankriders).
Coal Conveyor Staff Time Sheet. Weekly. From Coal Office to Accountant (covering conveyor drivers and greasers).
Cranemen, Locomen, Time Sheet. Weekly. From Traffic Office to Accountant.
Warehousemen, Watchmen, Time Sheet. Weekly. From Traffic Office to Accountant.
Waterboatmen Time Sheet. Weekly. From Traffic Office to Accountant.
Other Traffic Time Sheets. Weekly. From Traffic Office to Accountant.
Summary of all Traffic Wages. Weekly. From Traffic Office to Accountant. Embodied by Accountant in Wages Summary for all departments of Undertaking.

The Books.

Foremen's Note Book. Daily record of work proceeding on the dock with particulars of services being rendered by port authority's workpeople, in whose interest, and what cranes, engines or other appliances are being employed.
Traffic Day Book. Written up daily from Foremen's Note Book. Accounts to traders are made out from information in this book.
Foremen's Rough Time Book. Names of all weekly staff and number of hours worked daily. Posted to Traffic Time Book.
Traffic Time Book. Weekly time sheets compiled from this book.
Traffic Journal. Details of all traffic accounts are entered in this book. The ledger is posted from it, and the traffic abstract is compiled from it. The Register of Importers and Exporters is written up from it.
Traffic Ledger. Trader's accounts. Posted from Journal and Cash Book.
Traffic Cash Book. Record of cash receipts by Traffic Manager or Accountant. Posted to Ledger.
Traffic Abstract Book. Written up monthly. Cash totals of traffic charges under every head. This corresponds to the monthly Traffic Abstract sent to the Accountant. Monthly totals of all goods imported or exported. This corresponds with the Monthly List of Imports and Exports sent to the General Manager.
Register of Importers and Exporters. Kept in connection with triennial elections of Commissioners (governing body of the port authority). Posted from Traffic Journal. Records amount of Dues on Goods paid by each trader and thus shows whether he is qualified to vote.
Checkers' Books. Record of all merchants' goods handled on dock premises by port authority or stevedoring sub-contractors, showing disposal, i.e., to rail, to road, to craft, to open storage, or to warehouse.
Goods Stock Book. Compiled from checkers' books. Record of commencing stock and daily deliveries. Delivery charges and Rent charges are made out from this book, passed through the Journal, and accounts rendered to traders accordingly.
Grain Stock Book. As Goods Stock Book.
Goods Received Book (Rail). Kept at Weigh Cabin by Weigh Clerk. Entered up from tickets attached to wagons. Records all loaded wagons received from Railway Company. Date, time, number of wagon, contents, and weight. Subsequently entered on goods inward weigh sheets; haulage charges compiled therefrom.
Coal Teemers' Time Book. Made up at Coal Office from the Teemers' Sheets sent in by chargemen, and from staith foremen's rough Time Book. Records all teemers' wages.
Abstract of coal and coke shipments. Made out daily in Coal Office and totalled weekly, from coal teemers' sheets. Records number, class and capacity of wagons from the different collieries shipped at dock staiths. Declaration of Shipments sent to Railway Company is compiled from this Book.
Abstract of coal shipments. Entered up weekly in Coal Office and totalled monthly. It is based upon the weekly return sent by the Coal Office to the Railway Company. The monthly total is supplied to the Accountant to check against the Declarations sent by the collieries to him.
Vessels loading Time Record Book. Details of actual loading time of all vessels at Dock Staiths. Kept at Coal Office, from Teemers' Sheets.
Daily Record of Coal Shipments Book. Kept at Coal Office by Jetty Clerk. Entered up daily from Teemers' Sheets.
Summary of Shipments into coal vessels. Entered up daily at Coal Office from Teemers' Sheets, to record in particular how much coal, of each class, from every colliery, has gone into each ship loaded. Individual collieries sometimes ask for a Certificate to this effect.
Port Transport Workers' Wages Book. Entered up daily at Traffic Office from Foremen's Note Book. Relates to Registered men directly engaged by port authority (e.g., capstanmen, sheeters, checkers). Name, number, hours, job and rate of pay. Returned to Accountant weekly on form previously described.
Port Transport Workers' Wages Summary Book. Summary of foregoing, returned to Accountant weekly on form previously described.
Haulage Book. Entered up daily at Traffic Office and totalled monthly. The information is obtained from the Goods Inward (and Outward) Weigh Sheets sent in from the Weigh Cabin by the Weigh Clerk. Monthly rail haulage accounts on tenants' and traders' traffic are compiled from this book and sent out for payment.

Traffic Recording of Bonded Goods

Earlier reference has been made to goods landed from a ship and placed into bonded warehouse. Some port authorities have bonded warehouses of their own on the docks estate. The building must be one approved by H.M. Customs and must contain accommodation for the Customs Officer. Such warehouses are useful to traders importing dutiable goods because duty need not be paid until the goods go out, consignment by consignment, into home consumption. Charges for delivery into and out of the bonded warehouse will be raised by the port authority as in the case of a free warehouse and rent on the goods will also be charged at a tariff rate. The goods will be landed ex ship on an import entry passed by the importer and they will be placed into bonded warehouse under Customs supervision. Careful stock accounts must be kept by the port authority, in a form prescribed by H.M. Customs and be always open to their inspection. Before a delivery can be made, the importer must pay duty to H.M. Customs and obtain a delivery warrant to cover the goods. Goods may be delivered under bond in certain circumstances under a special warrant certified by the warehouse-keeper. Home consumption warrants also need certifying, and they must be handed to the Customs Officer promptly after delivery. Periodical stock returns must be made by the authority to H.M. Customs and no goods may be operated upon, in store, without H.M. Customs consent and careful recording in the stock account. Only an authorised person may sign documents on behalf of the warehouse-keeper, and the authorisation must be in writing and deposited with H.M. Customs together with a specimen signature.

Prime Entry

As described above, dutiable goods intended to be warehoused must be entered on a warehousing entry, but goods intended to be delivered out of charge forthwith on payment of duty must be entered on an entry (known as "Prime Entry") for home use ex ship. This transaction must be carried out with H.M. Customs by the importer or his forwarding agent. The port operator will deal with the goods, in the ordinary way, acting upon ship's release and forwarding instructions as previously described, and working in association with the Customs Officer at the berth.

Port Health Authority

In nearly all U.K. ports the municipal authority is also constituted the port health authority under the Public Health Acts. The authority's chief executive officer is the Port Medical Officer of Health, who has a staff of assistants, including port health inspectors and rat catchers. They have headquarters in the port area. Their functions include:—

(1) The prevention of the importation of infectious disease;
(2) The prevention of the importation of rat plague;

Port Operation—continued

(3) The carrying out of the terms of the International Sanitary Convention, 1926, particularly in regard to the granting of deratisation and deratisation exemption certificates;
(4) The supervision of the hygiene of crew and passenger accommodation in ships;
(5) The inspection of imported food;
(6) Supervision of the general sanitary condition of the port area.

The officers of the authority operate under the Port Health Regulations, 1933. They meet and board vessels arriving from foreign or coastwise and co-operate with H.M. Customs in securing from the master a Declaration of Health. They supervise and advise upon arrangements for the disposal of ship's refuse whilst in port. The fumigation staff of the authority disinfects verminous quarters. They keep under inspection the arrangements and appliances for supplying fresh water to vessels in port. They search vessels for evidence of rats and either furnish the master with a Deratisation Exemption Certificate or, if necessary, carry out the trapping or destruction of rats on board, subsequently issuing a Deratisation Certificate if they are satisfied. They are competent to deal with conditions on board ship adversely affecting the health of the crews and, in certain directions, their powers are concurrent with those of the Surveyors appointed by the Ministry of Transport. They deal with cases of infectious disease on ships arriving, having previously been notified by wireless from the vessel. They arrange with the port authority for the provision of a special berth, or berths, for the isolation, at the discretion of the Medical Officer, of vessels suspected of having infectious disease on board; alternativtly, they can allow such vessels to proceed to their normal working berth under a modified form of Pratique and under close restrictions as to persons boarding or leaving the ship.

The Traffic Manager's Day

We have looked at the duties of some of the Traffic Manager's assistants and we have discussed their work, the information they collect, the records they compile, and what they do with them. But the only person who sees the whole picture is the Traffic Manager himself. We therefore conclude this part of our study of port operation by a brief diary of an ordinary day on the docks estate from a Traffic Manager's point of view in the Undertaking referred to above.

His office is fairly centrally placed on the Estate and his normal walk through one of the landward entrances, on the estate perimeter, to the Traffic Office, takes him past two or three of the principal berths and he can see others across the docks. He keeps his eyes open as he goes along, noting the handling of cargo across quays, in or out of warehouses, the placing and movement of cranes, wagons on or approaching berths, cleanliness of quays, number of locomotives operating within his view and what they are at, and thus gathers his first general impression as to what is going forward to-day and whether it accords with the estimates he formed and the forward arrangements he tried to make yesterday.

At his office he looks first at any special incoming letters which have been left for his perusal and if any require urgent action he will give directions accordingly. Replying to the letters themselves will be left till the afternoon.

At 9.30 a.m. his principal outdoor assistants will come in to report. These are the general traffic foreman on duty, and the mechanical foreman. The general foreman's chief care is the continuous movement of goods; the mechanical foreman is responsible for securing the continuous and efficient operation of machinery and appliances, and he is the Traffic Manager's liaison officer with the maintenance engineer's department. This morning conference discusses the vessels working, any moves from berth to berth that may have to take place during the day, and the empty wagon supply from the Railway Company. In regard to wagons, the Traffic Manager will want to know whether the number requisitioned yesterday have arrived or, if not, the number short. If the shortage is so bad as to entail the certainty of dockers standing idle waiting for wagons, arrangements may be made to pay off certain gangs at mid-day. The list of vessels immediately expected will be looked at and provisional arrangements made for berths, cranes and cranemen. This daily meeting is important but necessarily brief, so that the foremen may get back to their supervisory duties outside.

At 10 a.m. the Railway Company's Yardmaster calls to discuss yesterday's wagon requisition, to-day's supply, the prospects of getting more if required, and to-day's requisition for to-morrow's estimated needs. He also gives the Traffic Manager the latest information as to the degree of congestion or otherwise in the Railway Company's adjoining yard, and receives in exchange a summary of the position on the docks estate. He tells the Traffic Manager what trains (loaded and/or empty) he has waiting to pass into the dock premises and learns what there is to come out. This daily meeting, also, is most important and very valuable. Commonly, it is freely interrupted by telephone calls and messages for both officials, and the usual procedure is for them to agree that the joint task before them is nearly impossible and then to go on to find ways and means of achieving it—or a great part of it. They are apt to differ sharply between themselves, but to unite swiftly and effectively to deal with emergencies and keep traffic moving.

At 10.30 a.m. the Dockmaster calls to discuss arrivals, sailings and berthage problems. He lives on the estate and has dockhead staff and lockgatemen on duty all round the clock; he can therefore give the Traffic Manager any necessary information regarding occurrences—concerning ships, weather, personnel or plant—during the past night. These two are chiefly pre-occupied with making suitable berthing arrangements for vessels to arrive; they must consider their dimensions, the prevailing tides, and the cargoes against the background of vessels now working or already " on turn " waiting at buoys. Their deliberations may sometimes result in a reluctant decision to require several vessels to shift berths in order that one newcomer may be accommodated. They are not concerned only with vessels to discharge or load cargo, they must also provide for repairing vessls, new vessels fitting-out, bunkering-only jobs and other special cases.

At 11 a.m. the Traffic Manager aims to commence his daily two-hours' tour of inspection of the docks and the work going on. He will watch the rate of loading or discharging (reducing it mentally to so-many tons per hatch per hour) and he will associate it in his mind with the piece-rate agreed with the men, the manning of gangs, and the contract rate agreed with the master stevedore. He will carefully observe a particular gang from time to time, noting any instances of apparent over-manning or under-manning. Analysing operations further still, he will pay attention to the individual effort being put forward, here and there, by one man. He will note the type of cargo gear in use at different vessels and he will especially observe its state of repair. New or seldom-seen cargoes will interest him particularly; so will any vessel with an unusual arrangement of cargo space.

He will discuss such points and many others with the master stevedore at each vessel in turn, and he will go aboard with him to examine into any matters of interest. The work of the crane drivers, locomotive men and shunters will all come under his eye as he moves on round the docks. Repair work going on anywhere will engage his interest and he will notice the state of plant, roads, permanent way, shed roofs, handrails, steps and the like, all along his route.

If there is a vessel working more slowly than he had anticipated when estimating rates for her, he will go into the matter very carefully on the spot. The cargo may be more awkward than had been thought; special gear may be required; the manning of gangs may admit of improvement; the cargo may be coming forward (or coming out) in an inconvenient order; marks may be mixed owing to bad stowage on the other side: the berth itself may now be seen not to be so suitable as another berth might have been; or there may be a surfeit of road vehicles, owing to bad spacing, congesting the quay. All these points will be noted

Port Operation—continued

for immediate action, later action or future guidance, according to the possibilities.

The Traffic Manager will visit the dock tenants from time to time and particularly any of them who have a point to discuss with him regarding inter-working, dock services, handling of their traffic, future requirements, possible new developments or occupation of casual ground. Some matters he will dispose of himself; others he will report to the General Manager or the Chief Engineer.

He will hope to spend some part of the afternoon in his office —frequently preparing reports for the General Manager on questions affecting the improvement of operating facilities, the development of trade, or on labour questions raised by some section of the work-people or by their Trade Union. The calls upon his time made by labour matters are particularly heavy.

At fairly frequent intervals he gives time for meetings at his office with deputations of the work-people, their shop stewards and their Union officials. Day work having largely given place to piece-working, these meetings are often necessary to agree a piece rate on some new commodity. Meetings also take place so that the work-people may put forward a claim for " extras "— i.e., payment over and above the agreed rate because of alleged exceptional circumstances meriting an enhanced reward or rate per ton. Regional labour meetings also take place occasionally, sometimes necessitating a journey to the town or to a neighbouring town.

He has to meet the master stevedores from time to time to discuss their contract rates—more especially on new commodities. He has staff problems to deal with. He has a fairly continuous correspondence to conduct with traders concerning claims for alleged damages, shortages or delays. His telephone is seldom silent for long. He must make time on occasion to visit the Head Office of the port authority to be present at conferences with the General Manager, the Chief Engineer, the Dockmaster and the Accountant, to discuss problems and policy and to put forward his special point of view from the " operations " side.

His day is often long, but seldom long enough; but, again, it is nearly always an interesting day and therefore it seldom seems too long.

Special Acknowledgments

In preparing the above-given notes on the commercial routine involved in cargo handling, the authors desire particularly to acknowledge their indebtedness to the writers of the undermentioned valuable works and to recommend these books to all students for close and continuous study:—

" Shipping Business Methods," by Robert B. Paul (Sir Isaac Pitman & Sons, Limited);

" Shipping and Shipbroking," by C. D. MacMurray and M. M. Cree (Sir Isaac Pitman & Sons, Limited).

The following further publications are also recommended for additional reading:—

" The British Tariff System," by Maguire (Methuen & Company, Limited);

" Customs Regulations and Procedure " (H.M. Stationery Office);

" Customs and Excise Tariff " (H.M. Stationery Office);

Notice 203—By the Commissioners of Customs and Excise (Approval of Bonded Warehouses).

(To be continued)

Recovery in Dutch Overseas Trade.

The number of vessels which arrived at the Port of Rotterdam during 1947 was 5,963, totalling 9,900,000 n.r. tons, compared with 4,464, vessels totalling 5,912,000 n.r. tons in 1946. The total weight of goods handled in 1947 was 12,000,000 tons as against 8,000,000 tons in 1946.

Vessels entering the Nieuwe Waterweg in 1947 amounted to 6,540, of 10.7 million tons, compared with 4,711 vessels of 6.4 million tons in 1946.

The arrivals at Amsterdam numbered 2,443 vessels of 943,272 tons net, as against 1,706 vessels of 642,375 tons in 1946.

Notable Port Personalities

LIV—Mr. COLIN S. ANDERSON

Mr. Colin S. Anderson, who was recently elected Chairman of the National Association of Port Employers in succession to Sir Robert Letch, who has been appointed a member of the Docks and Inland Waterways Executive, assumed his duties on the 1st January last.

Mr. Anderson was born in 1904 into a family that has for generations been involved in shipowning, formerly at Peterhead and Aberdeen and latterly in London as the firm of Anderson, Green & Co., Ltd., Managers of the Orient Steam Navigation Co., Ltd. He was educated at Eton and at Trinity College, Oxford, and

MR. COLIN S. ANDERSON.

entered the family business in 1925. In 1928 he became Secretary of the Company and in 1930 a Director. He has twice visited Australia on the Company's business and worked there for some two years. As well as being particularly engaged with the shipbuilding programme of the Orient Line, he has also been closely connected with the industrial relations side of the Company's activities. In 1940 he became a member of the Employers' side of the National Maritime Board, and in 1944 was made Chairman of the London Ocean Shipowners' Dock Labour Committee. In 1945 he became Chairman of the Port Employers in London and subsequently a member of the London Board of the National Dock Labour Board.

He was the first Chairman of the London Seamen's Port Welfare Committee, set up by the Ministry of Labour, and is also on the Boards of the London Merchant Navy Club, the Dreadnought Seamen's Hospital and the Sailors' Home and Red Ensign Club; Chairman of the Technical Committee of the Chamber of Shipping and Shipowners' representative on the Ministry of Transport Working Parties on Safety of Life at Sea and on the Revision of the Rule of the Road at Sea.

Among his other interests, he is a Director of the Union Bank of Australia, Hon. Treasurer of the Contemporary Arts Society and a member of the Arts Panel of the Arts Council.

Dock and Quayside Lighting

By C. H. NICHOLSON, M.I.E.E., M.I.Mech.E.

(Continued from page 234)

Part 2.

Considerations in the Design of Lighting Installations

The requirements of a lighting installation may now be dealt with in detail, amplifying the items which have been given previously.

The Provision of Adequate Illumination Intensity.

When it is realised that the average daylight illumination intensities in June may approach 4,000 foot candles at mid-day, it is obvious that even the highest intensities of artificial lighting, say 100 foot candles maximum, fall very short of the intensities to which the eye is naturally adapted. Thus, while all lighting installations may be regarded as a compromise between initial cost, maintenance cost including power, and the degree and quality of illumination provided, the trend is to increase the intensity of illumination as a means of providing better seeing conditions and reducing eye strain.

The contrast in colour between the object to be seen and the background has a great bearing upon the amount of light required, the greater the contrast the lower may be the intensity of illumination, and the lower the contrast the higher is the intensity required.

It should be noted however, that with high contrast the intensity of illumination must not be too high or this may cause glare.

The size of the object to be viewed has also great bearing upon visual acuity, the smaller the object the greater the intensity necessary.

A further factor affecting the act of vision is the speed at which the viewed object may be moving, on account of the time required by the eye to focus the object, this time being reduced or increased according to the intensity of illumination.

Glare

Glare may be defined as a condition whereby light of high intensity not necessarily used for the purpose of viewing the object enters the eye, thus impairing vision. This may be due to the following causes, a light source of high brightness being in the direct line of vision, the contrast between the object and background being great, together with the use of high intensities, and reflection from highly polished or very light coloured objects, an example of the latter type of glare is a wet road illuminated to a high intensity by lighting sources having a high brightness.

In order to minimise glare therefore, the light sources should be mounted at heights and in positions sufficient to prevent direct vision of the light source. Where this is difficult or impossible, the brightness of the light source should be reduced by the use of refracting glassware and/or diffusing screens. To minimise contrast glare is difficult unless the contrast between the object and background is constant, which of course is rarely the case. Contrast glare however, is not so great unless extremely high intensities of illumination are used. Glare due to reflection may be minimised by placing the light source so that the reflected rays of light do not enter the eye. Generally speaking, the higher the mounting height relative to the horizontal distance between light sources, the less will be the chance of experiencing glare.

Shadows

Shadows, if not too deep, assist in the recognition of the object, but deep shadows may cause danger by masking danger points, and, if large enough for a person to enter upon, may be regarded as areas which are practically unilluminated, consequently, due to the characteristics of the eye, temporary impairment of vision takes place when entering or leaving the area in shadow.

The greater the brightness of the lighting source, the more intense will be the shadows, also, the lower the lighting unit mounting, the larger will be the shadows on horizontal planes. Shadows may be minimised by lighting the object casting the shadow from both sides, the use of diffusing screens on the lighting units, or the use of light sources having a low brightness, e.g., the fluorescent lamp.

Colour Perception

This is relatively unimportant in dock lighting except in cases where this may be necessary for the interpretation of coloured labels etc. Colour perception is not good with mercury and sodium vapour lamps; with fluorescent lamps there is little distortion, blue being somewhat intensified and there being some weakening of red colour.

The Provision of Uniform Illumination Intensity

Reasonably uniform intensity of illumination may be obtained by adhering to the spacing ratios for the type of fitting utilised, fittings being so designed that the candle power given on the various angles as shown on the polar curves, is such, that when fittings are correctly spaced with relation to mounting height, the effect of a number of fittings is cumulative, and hence gives uniform illumination.

The polar curves, and spacing ratios for the usual types of fittings in use are given in Figs. 1a to 1l.

The above refers to lighting of interiors and working areas only where the ratio of the maximum intensity and the minimum intensity should not exceed about 1.5.

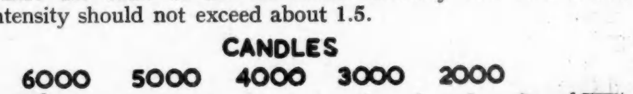


Fig. 2. Curve of "Cut-Off" Distribution.

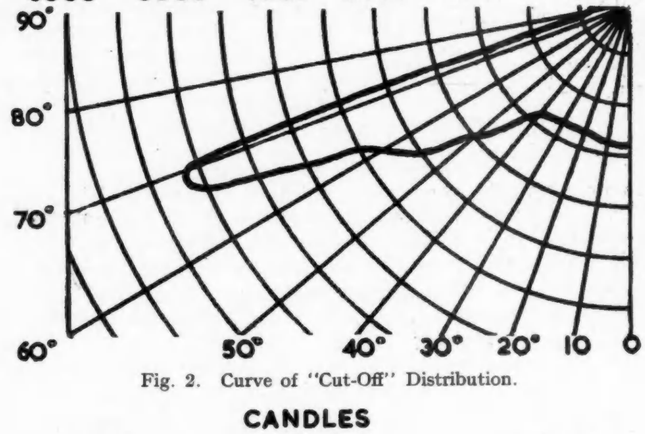


Fig. 3. Curve of "Non-Cut-Off" Distribution.

Dock and Quayside Lighting—continued

Roadways however, which cannot be regarded as working areas, are not, on account of the number of lighting units which would be required and the consequent cost, so uniformly illuminated and the corresponding ratio may be 6 or higher.

Dock Roadway Lighting

The provision of adequate dock roadway lighting, primarily for the purpose of affording safety to personnel, presents many difficulties, in as much that lighting of obstructions and danger points require special consideration, these constituting railway lines, capstan bollards, mooring ropes, cranes etc. The colour of all dock backgrounds is generally dark and contrast is therefore difficult to obtain, although the use of concrete roadways does considerably assist, as with these, silhouette preception referred to later, is obtainable with illumination intensities which are not unduly high. The problem therefore, revolves itself into providing sufficient lighting to create contrast in brightness between the object to be seen and the background, either by illuminating the object to a higher level of brightness than the background or creating a background brightness against which the object may be seen in silhouette.

The first method is scarcely practicable on account of the high candlepowers necessary and the number of lamps required, which in turn, produce excessive glare. The second method i.e. the creating of background brightness whereby seeing is by silhouette is therefore more generally utilised. On account of the presence of obstructions which may cause deep shadows, careful siting of lighting points is essential.

Where dock railways are adjacent to lighting installations, consideration must be given to prevent interference to signal lighting, by the light emitted from lighting units and careful siting and shielding if necessary, is essential.

The usual methods of producing silhouette lighting are as follows:—

The use of a fitting having "cut off" distribution the cut-off being at the angle 70° as shewn in Fig. 2.

Upon roads having a rough surface a fitting having a light distribution as shown would give good results provided the road width does not exceed about 35-ft. and the spacing of the lamps is not more than 110 feet, and the mounting height is approximately 25 feet from ground level. Glare is reduced to a minimum but if the spacing is unduly increased, dark and bright strips across the road will be apparent causing difficulties in vision.

The alternative method is by a fitting having "non cut-off" distribution as shown in Fig. 3. the maximum candle power being given at 75° and maintained to 85°. Below 85° the light distribution is sufficient to give local illumination around the lamp standard.

A certain amount of glare is inevitable but this can be kept within such limits as not to cause undue disability to the road user. With this type of lighting, as the distance of the observer from the lamp is increased, the illuminated area assumes the shape of a " T," the tail being towards the observer.

Reduction in the mounting height or increase in the spacing of the lamp standards increases the length of the tail of the "T", the centre areas becoming narrower and brighter whilst the side areas become larger and darker, the general effect thus being to give patchy illumination.

Comparing the two systems therefore the broad results are that the cut-off method of light distribution gives minimum glare but unless the number of lighting points is very large, patchy illumination results. (Figs. 4 and 5).

Generally, road lighting installation should have lamp standards having an average of 150-180 feet spacing which, on bends, may be reduced to 90 feet with lanterns mounted 25 feet high. The overhang of the lantern over the roadway must be in consideration to road width, and if this latter is great, then if possible, both sides of the roadway should be provided with lighting points which may be preferably staggered. In any case positioning can be only adequately dealt with on the site, due regard being paid to the background i.e. colour of buildings etc., bends, roadway intersection, roadway junctions etc. Poles of good design are available in cast iron, steel tubing and concrete, the latter having the great advantage that they eliminate painting.

Provision should be made at the base of the column to house the incoming cable, terminal box, time switch, relay, choke and condenser.

Generally the design of the pole, if of steel, should be such that no parts collect water and no electrically dissimilar metals are in contact, as this induces corrosion.

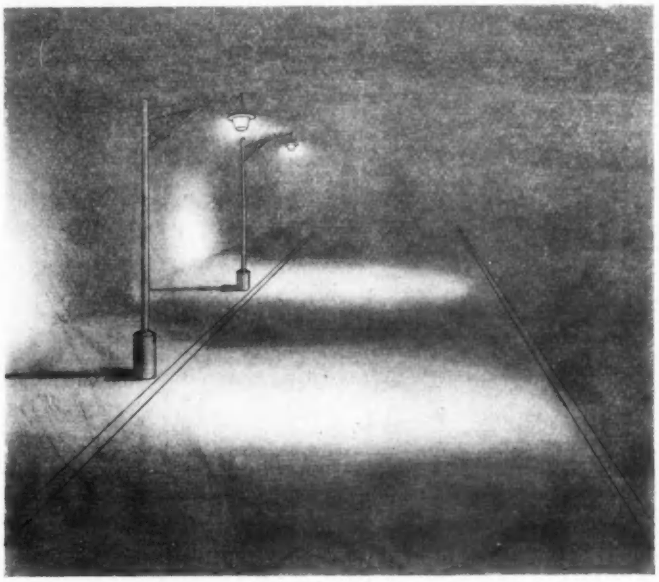


Fig. 4. "Cut-Off" Lighting Distribution.

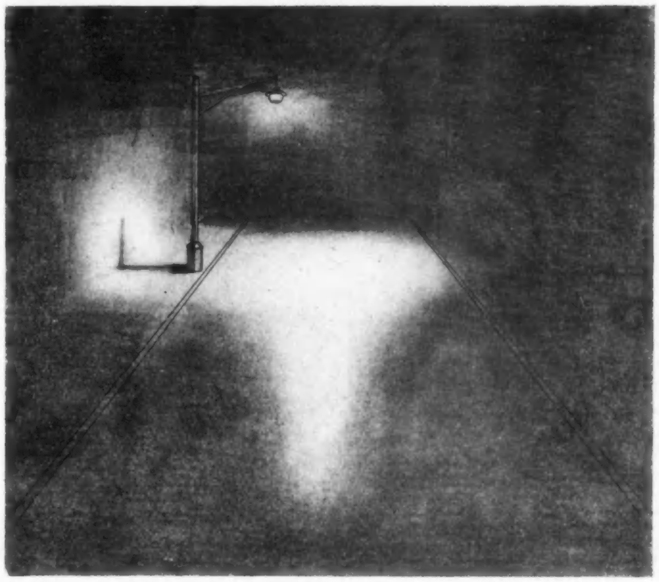


Fig. 5. "Non-Cut-Off" Lighting Distribution.

Bracket arms are preferably designed to appear as integral parts of the lamp standard itself and scroll work should be absent as this increases painting, maintenance and liability to corrosion.

The lighting fitting itself may be of the enclosed or open type, the former by the use of suitable glassware (refractor) has the advantage of giving a little better light distribution. (See Fig. 11).

The disadvantages of the enclosed type are, first, it is more costly, and secondly, it is more liable to damage.

Where electric discharge lamps are used, some form of enclosed lantern is often necessary. The lantern should be securely fixed

Dock and Quayside Lighting—continued

to the bracket, and it is most essential that the fitting itself should be absolutely waterproof, and so designed as to facilitate easy wiring. It is preferable in all cases that the fitting may be wired in the workshop prior to erection and where a portion of the fitting is detachable, the detachable portion should be secured by not less than three bolts.

Where electric discharge lamps are utilised, the horizontal burning high pressure mercury vapour lamps and horizontal burning sodium lamps are sometimes fitted into open troughed lanterns.

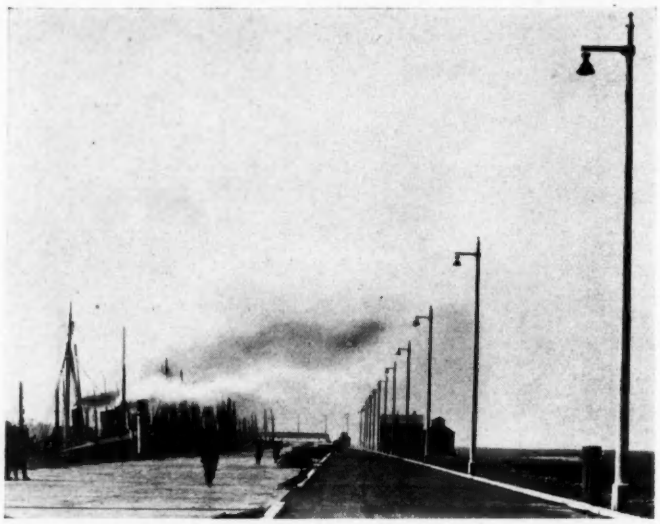
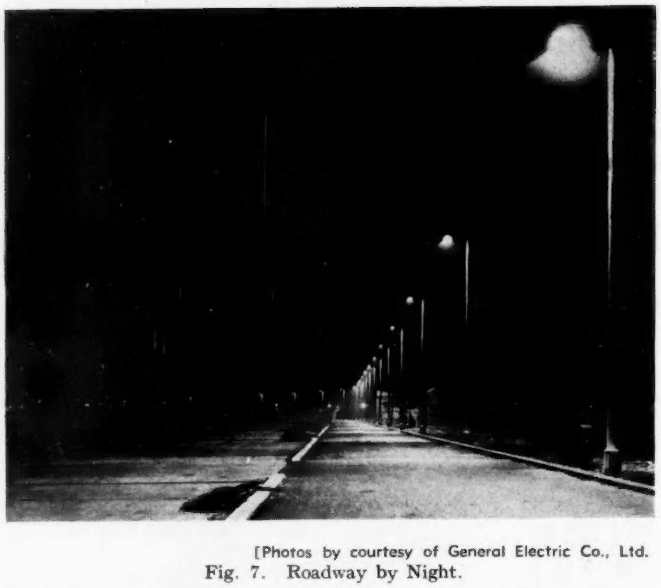


Fig. 6. Roadway by Day.



[Photos by courtesy of General Electric Co., Ltd.
Fig. 7. Roadway by Night.

The vertical burning lamps are fitted into reflectors or lanterns similar to those used for metal filament lamps, with or without the addition of glassware diffusing skirt.

If either the enclosed lanterns or the open reflector fittings are used these should be provided with a focussing arrangement, and some indication of correct setting should be incorporated in the fitting.

The fittings are comprised of mottled design silvered glass reflector housed in a non-ferrous metal body and provided with refracting glassware at the bottom. (See Figs. 6 and 7).

The type of lamp used is 1-500-watt metal filament lamp, and the maximum illumination obtained at ground level is in the order of ½-ft. candle this being shown in the bottom half of Fig. 8.

Example of Dock Roadway Lighting (1)

Average spacing of lamps	120 feet (single row).
Width of roadway	73 feet.
Mounting height	35 feet from ground level.
Method of supporting fitting	Spun concrete poles 44 ft. overall length with concrete brackets projecting 3-ft. 6-in.
Lamp	One standard 500 watt tungsten filament lamp.
Optical control	Silvered glass reflector with refractor.
Angle of light cut-off	71° to the vertical.
Maximum candle power	4600 candle power.
Maximum horizontal illumination at ground level	.6-ft. candle.
Minimum horizontal illumination at ground level	.1-ft. candle.
Lamp lumens per 100 ft of roadway ...	7050
Lamp lumens per sq. ft. of roadway ...	.97

Example of Dock Roadway Lighting (2)

Average spacing of lamps on straight portion of roadway	300 feet (two rows) staggered lighting units).
Width of roadway	45 feet.
Mounting height	25 feet from ground level.
Method of supporting fitting	Tubular steel pole.
Lamp	250 watt Mercury Vapour.
Optical control	Reflector with glassware skirt. Fitting as 8B.
Angle of light cut-off	85° to vertical.
Lamp lumens per 100 ft. of roadway ...	4850
Lamp lumens per sq. ft. of roadway ...	1.08

Note:—As a general rule at least 3000 lamp lumens per 100 feet of roadway is the minimum which should be provided or approximately 1 lumen per sq. foot of roadway.

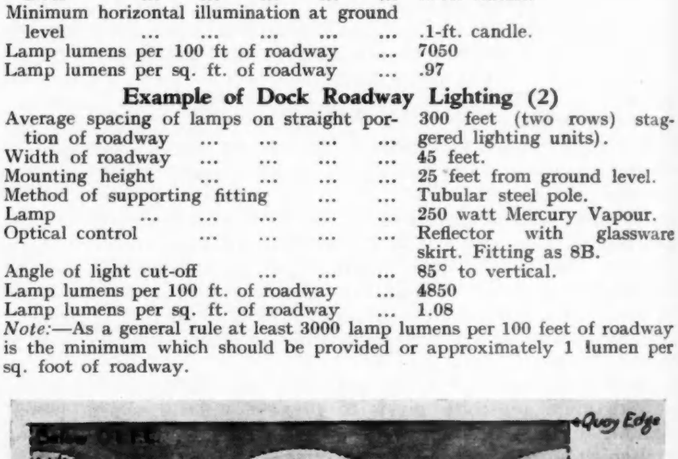


Fig. 8. Graph showing Distribution of Lighting at Quay Edge.

Quay Lighting

The lighting of Dock Quays presents a similar problem to Dock Roadway Lighting with the following qualifications. Quays usually have railways, cranes, capstans, mooring bollards, etc., installed upon them, and further, wagons may be moving or standing upon the Quay, and hence the question of poorly illuminated areas due to shadow requires great consideration. For the purpose of providing illumination during actual operation of discharging and loading, etc., lighting fittings suspended at each corner of the top of the crane pedestal are effective, and are dealt with under crane lighting.

Generally, lamps should be placed relatively high to obviate large shadows being cast by wagons, etc., and should be so positioned to adequately illuminate the quay edge.

Where lighting standards can be erected, it is possible to light quays by a similar method to that adopted for roadways. Where quays abutt up to warehouse walls, brackets carrying angle reflectors or refractors may be used, a fitting similar to that shown on Fig. 1e being used preferably at about 24-35-ft. mounting height with a spacing ratio of 1 to 1½ times the mounting height.

Where the breadth of the Quay is great and it is possible to mount at either warehouse walls or on standards away from the actual quay itself, a fitting similar to that shown in Fig. IE may be used. It should be mounted not less than 35-ft. high with a

Dock and Quayside Lighting—continued

spacing as near as possible equal to twice the mounting height, the candle-power of the lamp used being such as to give an illumination of not less than 1 to 1.5-ft. candles at ground level.

To generalise quay lighting should be designed on the basis of not less than one lamp lumen per sq. ft. Widths of not more than 45-ft. may not be lighted from one side only, unless the mounting height of the light source is increased to about 35-ft. Where cranes are installed on quays, it is desirable to provide general lighting to an intensity represented by one lamp lumen per sq. ft. equivalent to about 0.5 candle feet. This would be augmented by what may be termed working lighting, by the installation of lighting sources fixed at the corners of the top of the crane pedestal, and designed to give intensities up to 5 foot candles.

The general design data of an installation is given below:—

Length of Quay	1300 feet.
Width of Quay	73 feet.
No. of cranes on Quay	12
Mounting height of units	35 feet.
Lamp	500 watt gas filled tungsten.
Optical control	silvered glass reflector with refractor.
Angle of cut-off	71° to the vertical.
Maximum candle power	4600
Maximum intensity	6 foot candles.
Minimum intensity	1 foot candle.
Spacing ratio	3.4 to 1.
Spacing of lighting units	120 feet.

Crane Lighting

This may be divided into three sections, first, the actual lighting of the crane cabin, second, the lighting of load, and third, the lighting of the area adjacent to the crane.

The first may be carried out most satisfactorily by prismatic directional fittings, and in any case the fitting chosen should be robust and unobtrusive. The lamps used are 40-60-watt tungsten filament.

Fully-shielded hoisting and luffing indicator lamps are desirable and inspection lamp service is essential. The latter is preferably low voltage where alternating current is available.

The lighting of the load is often carried out by the provision of a concentrating fitting of the reflector type fixed to the crane jib, a tungsten lamp 100-200-watts being used. The more modern method is by the use of box fittings fitted with diffuser or refractor glassware. The box fittings are installed at each side of the observation window, the wattage of the lamps being 300.

Lighting of the adjacent quay area, if necessary, may be conveniently done by means of dispersive reflector fittings fixed at each corner of the top of the crane pedestal. Using standard dispersive reflectors and 200-watt gas-filled tungsten filament lamps at an approximate mounting height of 50-ft. gives an intensity illumination of 2/5 foot candles on a circular area having a radius of 50-60-ft. from the crane centre.

Where an A.C. supply is available, it is good practice to provide a small lighting transformer giving services at 110 or 250-volts and 25-volts for the main lighting and inspection lamps respectively. If, however, the electricity supply is direct current, then it is usual to use two lamps in series per circuit up to 500-volts direct current.

Marshalling Yard and Siding Lighting

Two general methods are available (a) the use of standards carrying dispersive fittings or messenger wires spanning the siding or portion of it, the lighting fittings being carried by the messenger wires, (b) the use of projector and flood lighting.

Dealing with (a) the possibility of using this method is decided by the space available between the railway tracks to accommodate the lighting standards, and also whether general illumination is necessary or whether the lighting is to be localised at crossings and shunting roads.

The same general rules apply here as for roadway lighting with the additional provision that the lighting units must be so placed to prevent wagons, etc., casting shadows and thus causing dark patches. If sufficient space for lighting standards is not available and the sidings are not too wide, the messenger wire system is an alternative.

The second system, i.e., (b) flood lighting may be used in difficult situations, the flood lighting fittings being mounted 40-50-ft. above ground level and provided with focussing gear and universally adjustable brackets.

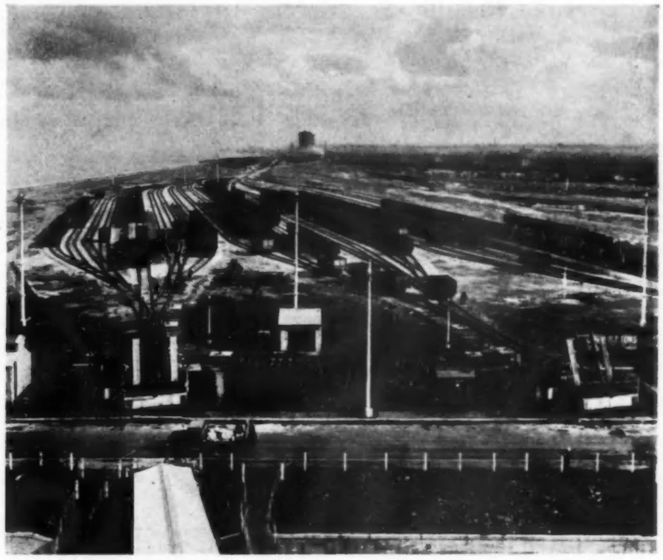


Fig. 9. Showing an Arrangement of Floodlighting Standards.

[Photos by courtesy of General Electric Co., Ltd.

Fig. 10. The same installation by night.

The floodlights are usually arranged, one set at each end of the sidings facing each other as shown in Fig. 9.

This arrangement reduces the dark patches caused by shadows.

The type of fitting is a parabolic reflector, with heat-resisting front glass, and the lamp used may be standard or projector type tungsten fitment, mercury vapour or sodium lamp.

The angle of the beam is usually about 30°.

A typical installation by night is shown in Fig. 10, the particulars of which are as follows:—

Distance between each group of floodlights	370 yards.
Height of floodlights above ground ...	45 feet.
Lamps-standard tungsten	1000 watt.
Optical control-Parabolic silvered glass reflector.	
Maximum candle power from one floodlight	84,000 C.P.
Beam angle	28°
Illumination at mid span	.06 to .1 footcandles.
Lamp Lumens per sq. foot	.45
No. of floodlights	7

(To be continued)

Storm Surges

Their Importance in Modern Tidal Science and Some Results of a Recent Investigation

By R. H. CORKAN, M.Sc.*

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1. The present position concerning accurate prediction of the tides—need for further study of storm effects.

Ever since the Admiralty in 1836, using the results of Lubbocks' researches, published their first comprehensive tide tables for British Ports there has been an increasing demand for more accurate tidal predictions.

Fig. 1.—The most effective winds for raising sea level at places on the British Coasts.

One obvious reason for this demand has been the increase in the size of ships using the ports but probably a more important factor has been the steady rise in running costs and the loss which is involved when a ship misses a tide. So as to save time, not infrequently in these days, pilots are obliged to navigate vessels over bars and up tidal channels with a very small margin of water under their keels and this is only possible with safety when the tides are accurately known.

The problem which meets the tidal expert if he is to provide accurate predictions may, for convenience, be divided into three parts.

First he must be able to predict accurately the astronomical tide or that part of the change in level which arises directly from the tide generating forces of the sun and moon.

Secondly, he must be able to predict accurately the distortions in the astronomical tide which are produced when a wave travels in shallow water, and, also, as a result of friction. These distortions are of terrestrial origin.

Thirdly, he must be able to predict, or provide a simple method which the seaman may himself use to predict, the meteorological tide, or that part of the change in level which is produced by the casual effects of pressure and wind.

*Deputy Director, Liverpool Observatory and Tidal Institute.

The work done in the last hundred years or so to find a satisfactory solution of the first and second parts of the problem will be familiar to all who have made a study of the Reports of the British Association and of papers by Lubbock, Whewell, Bunt, Darwin and others in the Philosophical Transactions of the Royal Society. Yet as late as 1920 the position was shown to be far from satisfactory where predictions of high accuracy were required.

To-day, largely as a result of the researches in the past 25 years of Dr. A. T. Doodson, F.R.S., Director of the Tidal Institute, this unsatisfactory state no longer exists.

Dr. Doodson's work started in 1921 with a very thorough and detailed development of the tide generating forces, an essential preliminary if all important constituents of astronomical origin are to be sought. This was followed in 1928 by a greatly improved and simplified method of analysis which, besides providing many more constituents than any previous method, gave special attention to the elimination of the effects of unwanted constituents and reduced the labour and cost of an analysis to only a fraction of what it had been before.

The present position as regards the astronomical tide is that at a place such as Liverpool, where the range at springs is of the order of 30-ft., the predicted error should not exceed 1 or 2-in.

The preparation of satisfactory predictions of the distortions in the astronomical tide, due to the very slow convergence of the higher harmonics, has presented a difficult problem. One solution is to build much larger predicting machines or, if only hourly heights are required, to use tabulating machines of the Hollerith or Powers type. Just before the war the Germans constructed a 62 component machine, having 22 components more than the previous largest machine, the Légé, at the Tidal Institute, but even this number of components would be insufficient at certain places.

When accurate predictions of only high and low waters are required then indirect methods of prediction may be used and an important recent development produced by Dr. Doodson has been the Method of Harmonic Shallow Water Corrections which is really the harmonic analogue of the older non-harmonic method of differences. This method has given completely satisfactory results at all important British ports and at certain foreign ports where it has been employed. As an extreme example the method has been very successful at Basra, on the Shatt-al-Arab, where previously, due to the large diurnal as well as semi-diurnal distortions, prediction had to be given up as practically hopeless.

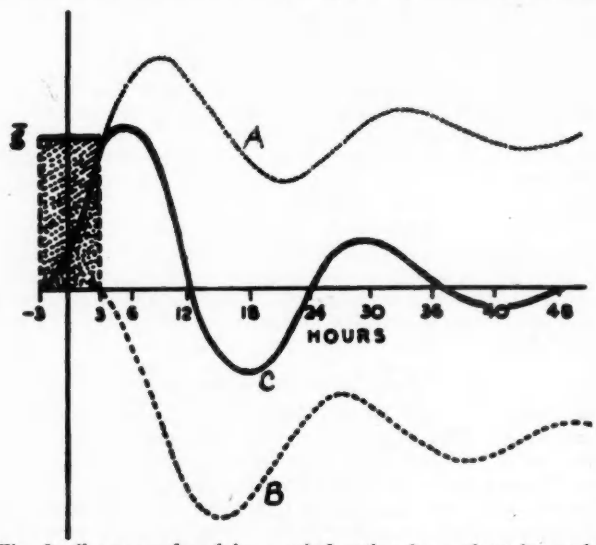


Fig. 2.—Surge produced by a wind acting for a short interval of time.

It may now be safely said that as far as both the astronomical tide and its distortions are concerned these are, or can be, predicted with all the accuracy required, and they no longer present a major problem to the tidal expert.

Unfortunately no similar statement can be made concerning the meteorological tide.

Storm Surges—continued

The effect of pressure alone, assuming that the sea acts like an inverted barometer, has been considered on a number of occasions, but the effect of the wind, the really important factor in the majority of large disturbances, has not received the attention its importance deserves. This has been due partly to the inherent difficulties of the problem and also to the anomalous results to which any simple method of treatment normally leads. Numerous tables have been prepared showing the effect on the tides of the local winds when from different directions and of varying strength, but since these only depend on averages deduced from the grouping of a large number of observations they are of very little use for the purpose of predicting the disturbance on a particular day, especially when the disturbance is large; often they may indicate a lowering of level when the level is raised and the reverse.

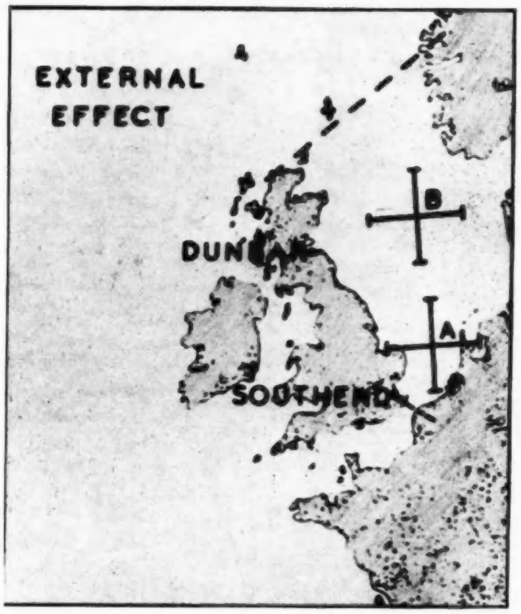


Fig. 3.—Position of Points "A" and "B."

Certain fallacious ideas have also grown up such as that the level of the sea is always raised when the local wind is onshore. Figure 1 is from a paper from Dr. Doodson published in 1924 and shows by arrows the directions of the local winds which are most effective in raising sea level at a number of places round the coasts of the British Isles. It will be seen that at certain places, as for example Felixstowe, the most effective direction may be nearly offshore.

To sum up we may say that a more complete understanding of how the meteorological tide is produced and the discovery of a satisfactory method of predicting it are probably the most important practical problems relating to tides awaiting solution.

A further and somewhat different reason for a more detailed study of storm effects is the importance, at places where flooding is possible, of a reliable estimate of the probability of the sea rising to specified levels, so that the sea defences may be suitably, yet economically, raised. When sufficient data are available this problem can be solved statistically. It is also sometimes desirable that forecasts may be issued of when the sea is likely to reach dangerous levels.

A preliminary investigation for which these were the immediate requirements was carried out by Dr. Doodson for the London County Council, after the flooding of the Thames and its disastrous results in 1928. Dr. Doodson traced the progression of several large surges in the North Sea and also carried out extensive correlations between the disturbance and the pressure and pressure gradients, both local and far afield. From these he showed the importance of time relations and the necessity to consider the conditions over a large area.

A further and more detailed investigation has recently been completed by the writer and a report issued to the same authority. This recent investigation will form the basis of much that follows in this article.

2. The magnitude and some characteristic features of the meteorological tide at Southend.

Some idea of the size and the relative importance of the meteorological tide may be obtained from the following table showing the frequency of errors in the predicted high water heights at Southend during the winter months of the ten years, 1929 to 1938, inclusive. The total number of observations was 3,479.

Error in feet	-6 to -7	-5 to -6	-4 to -5	-3 to -4	-2 to -3	-1 to -2	0 to -1	0 to 1	1 to 2	2 to 3	3 to 4
Frequency	1	1	3	9	32	202	1333	1587	283	23	5

Neglecting sign, more than one in fifty of the high water heights had an error of 2-ft. and over, while more than one in two hundred were in error by 3-ft. It will be realised, of course, that the maximum disturbance is in general greater than the disturbance at the time of high water since it is only on rare occasions that the time of maximum disturbance and the time of high water coincide. The largest known disturbance at Southend since 1911 was a raising of level of over 11-ft. which occurred two hours after low water on December 31st, 1921.

The table of errors also indicates that the tides at Southend tend to be lowered by meteorological effects more than they are raised, and investigation has shown that this cannot be attributed appreciably to any fundamental difference in the response to conditions favouring a lowering of level to those favouring a raising of level. The more probable explanation is that in the North Sea the former conditions are, on the average, more intense.

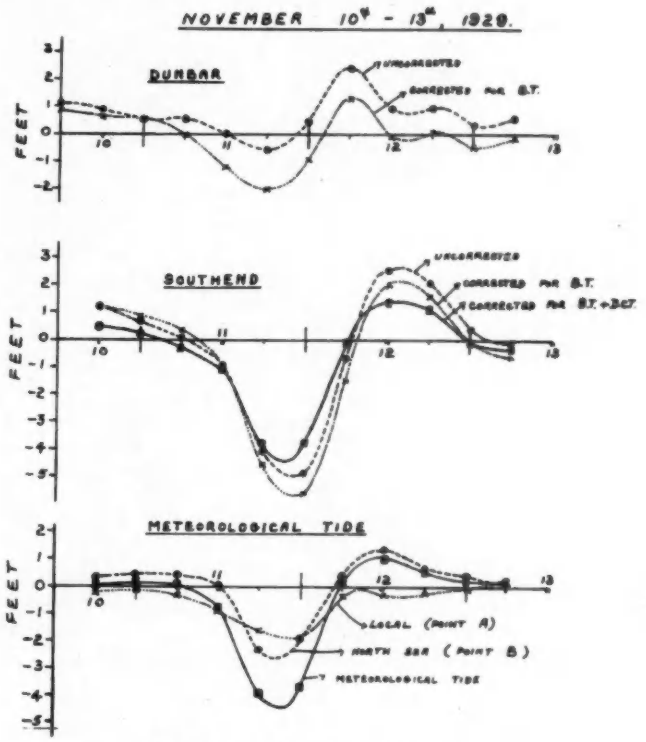


Fig. 4 (a).—Surge of November 10th-13th, 1929.

Detailed examination of the meteorological tide at Southend has also shown that it is partly dependent on the range of the astronomical tide. When the range is small there is a greater tendency for large storm effects at the time of high water, particularly those in which the level is lowered, than when the range is large.

Storm Surges—continued

The probability of the tide reaching a specified level is usually based on a statistical study of a frequency table such as the above. Graduation of the table of errors gives the probability of errors of a specified size; these results, when suitably combined with the probability of the predicted tide reaching specified levels, give the required probabilities for the height of tide.

A much simpler method and one which gives good results when only a quick and easy approximation is required may be based on the observed fact that the logarithm of the crude probabilities of the observed high water heights is approximately linear with the height for large heights at Southend; using this method, the probability of the tide rising to the same level as that which produced the flooding in 1928 came out as one in thirty years, using the more exact method the probability was one in forty-four years, results which are in reasonably good agreement.

3. The internal forces involved in the generation of storm effects.

The motion of water under the influence of wind is essentially a problem involving the frictional forces set up when one layer of liquid moves relative to another.

Movement of the wind over the upper surface of the sea sets up a drag or tractive force which draws the surface water after it; movement of the surface water produces a similar force on the water immediately underneath, and this in turn acts similarly on the next lower layer of water. The process is repeated for lower and lower layers until eventually the motion of the surface, with certain limitations, is communicated to the water as a whole.

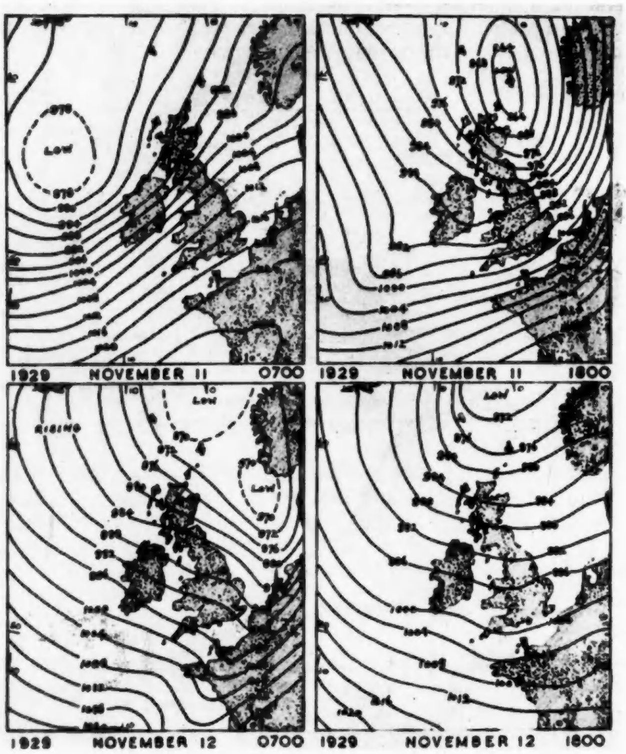


Fig. 4 (b).—Meteorological conditions during surge of November 10th-13th, 1929.

Each lower layer of water also exerts on each upper layer an equal and opposite hindering force which tends to bring the upper layer to rest. These two mutual forces, one tractive and the other hindering, are always set up when one layer of water moves relative to another and the phenomenon which gives rise to them is known as viscosity. So long as the particles of liquid follow well defined paths and the motion is what is known as steady, the laws which govern viscous motion are well known and may be determined in the laboratory. In the sea, however, though the mean paths of the particles may be well defined, there are in addition random motions of smaller and larger masses of the water passing from one layer to another and carrying with them their characteristic properties of temperature, density, momentum, etc.

These random motions greatly increase the normal frictional forces, so that the laws determined in the laboratory no longer apply; the motion as a whole is then said to be turbulent.

To distinguish the frictional forces in the presence of turbulence from those when it is absent, it is usual to refer to the former as the virtual viscous forces and the empirical constant which defines them is called the virtual co-efficient of viscosity. In the sea the virtual co-efficient of viscosity is only known approximately for a very limited number of cases, but such investigations as have been made indicate that its magnitude may be many hundred times that of the normal viscosity

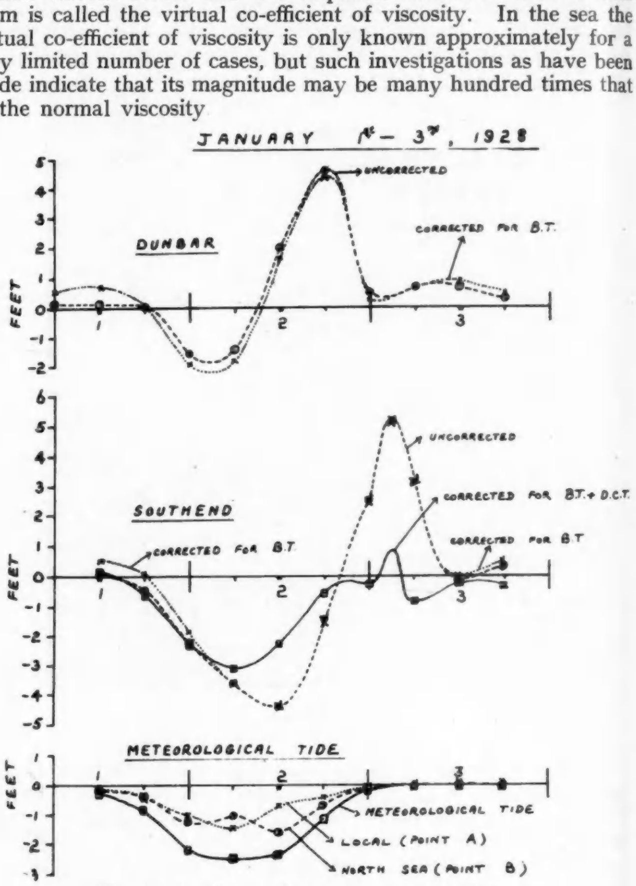


Fig. 5 (a).—Surge of January 1st-3rd, 1928.

At the sea bottom there are further hindering forces depending on the roughness of the sea bed. In shallow water these forces are often of considerable importance and in estuaries where the streams and elevations are well known they may be determined empirically with moderate accuracy.

In theoretical investigations it is usual to assume one of three conditions on the bottom—either no bottom slip, no bottom friction or finite bottom friction. Within molecular distance from the bottom the first of these conditions is generally accepted to hold, but from a practical point of view the assumption of some slip or finite bottom friction is almost certainly to be preferred.

The generation of a storm effect under the influence of a pressure gradient, in so far as the internal and bottom forces are concerned, is exactly similar to that under the influence of wind. The external forces, however, now act over the surface as a whole according to the statical law.

4. Storm Surges and how they are generated.

The term storm surge strictly implies a disturbance in sea level which requires the use of dynamical rather than statical considerations to explain its origin. In practice the term is applied to all large meteorological disturbances of an oscillatory character in an

Storm Surges—continued

enclosed or partly enclosed sea irrespective of whether the whole of the disturbance may be a surge in the true sense of the term or not.

The theory of surges for the very simple case of an enclosed canal was first given by Proudman and Doodson in 1924.

Previously in 1905, Ekman had shown that a steady wind blowing along a canal would ultimately produce a uniform slope of the surface, the end nearest from where the wind blows being lowered and the other end raised, the total volume of necessity remaining constant. To the final disturbance he gave the name steady state and he also provided a simple formula involving the tractive force of the wind for calculating it. Previously in 1881, Colding had shown empirically that the slope was directly proportional to the square of the wind velocity and inversely proportional to the depth.

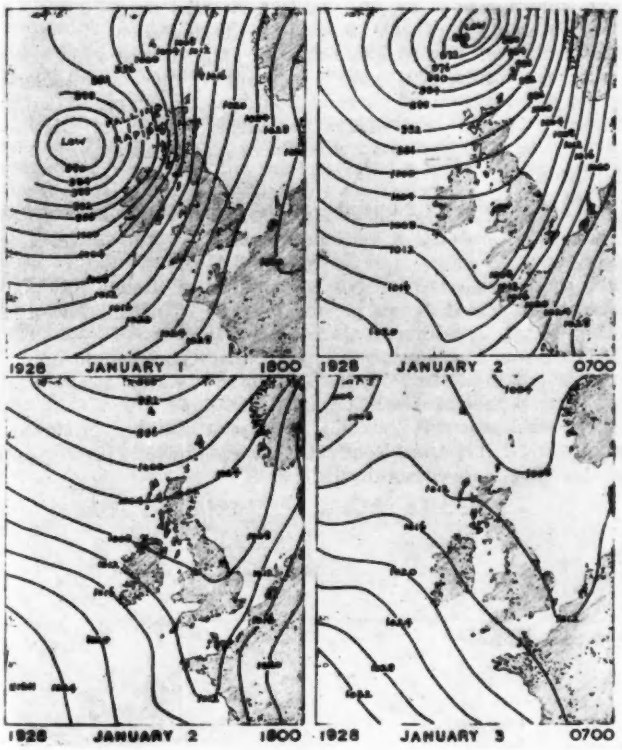


Fig. 5 (b).—Meteorological conditions during surge of January 1st-3rd, 1928.

Proudman and Doodson showed that if the wind suddenly commenced to blow and later remained at the same strength then the level at a particular point would approach the steady state in a series of oscillations after the manner of curve A in Figure 2 where the line $\bar{g}$ marks the value of the steady state.

The period of the oscillations would depend on the natural or seiche period of the canal and the time at which the level would reach its first maximum would be nearly one quarter of a period later than when the wind commenced to blow. The rate at which the oscillations died out would depend on the effective internal friction of the water.

If the wind, after blowing for a short time, suddenly ceases, then later conditions may be found by super-imposing the effect of an equal and opposite steady state as in curve B. Adding up curves A and B we get curve C, the effect of a wind blowing for a short interval of time.

When a curve for the steady state is known we simply divide it up into suitable time intervals and assume conditions in each interval to be constant. The intervals are then treated as above and the results summed continuously.

When the appropriate steady state for the effect of varying pressure gradients is known it may be treated in exactly the same way as the steady state for the wind.

Proudman has also considered the effect of a travelling depression and has shown that when the rate of travel reaches a critical value, depending on the depth, a large surge may be developed. This result has only received very limited application up to the present, but it may be fundamental in explaining the origin of certain large surges which originate outside the North Sea and later enter from the north and travel southwards like progressive waves.

5. Storm Surges in the North Sea.

According to modern theory the tides in the North Sea are standing oscillations maintained by the oceanic oscillations from the north. The tides in the English Channel have little effect on those in the North Sea due to the very narrow connecting channel in the Strait of Dover and, in fact, the tides in the North Sea would not be appreciably altered if a barrier was placed across the Strait.

The main oscillation in the North Sea is longitudinal and from north to south, but there is a smaller super-imposed transverse oscillation due to the earth's rotation.

If we neglect the earth's rotation the North Sea may be regarded to a first approximation as a long canal closed at its southern end and open to the ocean in the north. Internal storm effects over the North Sea as a whole may then be expected to be similar in a general way to those already indicated by simple theory.

External storm effects will enter from the north and investigation has shown that in the North Sea they travel southwards like a progressive wave. The origin of all external storm effects has not been satisfactorily explained, but it is easy to allow for them at Southend, simply by observing the disturbance, several hours earlier, as they pass the northern entrance. The time taken for a surge to travel from Dunbar to Southend is found to be practically 9 hours, while the ratio of amplitudes of surges at the two places is nearly unity, results which are in agreement with the progression of the tides. The same laws apply whether the level is lowered or raised.

In addition to the effect of the winds acting over the North Sea as a whole there are also local effects produced by the local winds when these differ appreciably from the mean wind over the whole area. The local slope is then expected to be proportional to the square of the local wind velocity; empirical investigation also indicates that the local effect is nearly instantaneous with the wind.

In regions where there are large stretches of shallow water there may be a local effect which is related to the height of tide since wind effect is greatest when the depth is least. Where there are large banks which become dry during a part of the tidal period the smallest average depths and the greatest wind effects do not necessarily occur at the time of low water. At Southend there is a marked tendency for the greatest effect to occur two or three hours after low water.

In shallow water part of the surge may also originate from interaction between the travelling surge wave and the ordinary tidal wave in the same way as shallow water effects are produced by ordinary tides (i.e.,) through distortions of the waves. These effects take the form of short period oscillations and at Southend they are sometimes very pronounced.

Also there may be local seiche effects, usually having very short periods.

In the recent quantitative investigations of storm surges at Southend the differences between the disturbances at Southend and Dunbar were expressed in terms of the squares of the pressure gradients at two points A and B situated as in Figure 3. Theory indicated that this difference could be expressed most conveniently and yet very satisfactorily in the form

$$R_S - R_D = \alpha\, N\,|N| + \beta\, E\,|E| + \gamma\, n\,|n| + \delta\, e\,|e|$$

where R_S is the observed disturbance at Southend after correction for the effect of local pressure assuming a statical law.

R_D is the observed disturbance at Dunbar after correction for the effect of local pressure assuming a statical law, 6 to 10 hours earlier.

Storm Surges—continued

N and E are the north and east gradients at A.

n and e are the north and east gradients at B, 6 to 10 hours earlier.

α, β, γ and δ are constants.

The expressions $|N|$, $|E|$, etc., mean that the gradients are taken without regard to the sign. The constants α and β between them give a good representation of the local wind effect at Southend. The constants γ and δ give a representation of the wind effect over the North Sea as a whole, but also include a portion of the Dunbar local wind effect.

The laws governing the propagation of external effect inside the North Sea were first determined using surges in which the effects of the winds over the North Sea were either negligible or as small as possible.

Choosing surges in which external effect was small and the wind effect over the North Sea was large, the above formula was next applied to determine the four constants and the best time intervals. Conditions favourable to a lowering of level were considered independently of those favourable to a raising of level and, as already indicated, the two sets of constants were found to be in close agreement. The consistency of the constants under similar conditions were also examined. In every case special care was taken to choose only those surges which gave equations, for the determination of the constants, which were well conditioned. When necessary, surges were re-examined and second approximations were made and in fact the whole process of analysis was one of successive approximation. Finally the accepted formula was thoroughly tested out and used to predict a wide selection of surges, most of which were unsuitable for the direct determination of the constants. In all, over 30 of the largest surges between 1928 and 1938 were examined in detail and satisfactory predictions obtained. The individual parts of each surge, external, local and North Sea effects, were also discussed in relation to the respective meteorological conditions which produced them.

Finally after the completion of the quantitative investigation the whole of the data was re-examined qualitatively making full use of the facts which had come to light.

It was found that practically all surges in the North Sea, both those in which the level is lowered and those in which the level is raised, can be expressed in terms of nine fundamental types, several of which are related in pairs. Three types produce a lowering of level and six types a raising of level and each type has a distinctive meteorological distribution and produces a distinctive effect on sea level. A particular surge may be made up of a single type or a combination of types. For example, one type may be producing a lowering at Southend through the local winds; a second type may be producing externally a raising of level. The observed surge will be the sum of the two effects and may be a raising of level, a lowering of level, or no apparent perturbation of level. One thing that is certain is that it is only by considering what happens both inside and outside the North Sea that a satisfactory prediction can be made.

6. **Some examples of storm surges at Southend.**

We shall now give three examples, from the recent report, of typical storm surges at Southend, with the associated meteorological distributions.

Space does not permit of the inclusion of further examples of equally important types or of a detailed discussion of each surge, but the following notes should be sufficient to indicate what has been done and to bring out the points of interest in each example.

The diagrams have been drawn on a uniform plan and the interpretations of the curves are as follows:—

1. **Dunbar.**
   (a) uncorrected—the uncorrected surge;
   (b) corrected for B.T. (Barometric Tide)—the surge after correction for the local barometer assuming a statical law.
2. **Southend.**
   (a) uncorrected—the uncorrected surge;
   (b) corrected for B.T.—the surge after correction for the local barometer assuming a statical law;
   (c) B.T.—the barometric tide (when given, the uncorrected curve is omitted since the barometric tide is very small);
   (d) corrected for B.T. and D.C.T.—the surge after correction for the local barometer and also for the "Dunbar Correction Tide," the corrected disturbance at Dunbar 9 hours earlier.
3. **Meteorological Tide.**
   (a) local (point A)—the local effect at Southend as deduced from the gradients at the point A;
   (b) North Sea (point B)—the general effect over the North Sea and a portion of the local effect at Dunbar as deduced from the gradients at the point B. (No attempt has been made to separate the two effects since this was unnecessary for the purpose of prediction).
   (c) Meteorological Tide—the predicted meteorological tide from the pressure gradients at points A and B.

The importance of the externally generated surge is indicated by the difference between the curves 2 (d) and 2 (b).

The success of the prediction may be gauged from a comparison between the curves 2 (d) and 3 (c), but we must also remember that it is the uncorrected surge at Southend, the curve 2 (a), that is being predicted, and that the corrections for the local barometer and the externally generated effect have played an important part in the prediction.

Example 1. Surge of November 10th-13th, 1929 (Figs. 4a & 4b).

This surge produced a very pronounced lowering of level of a simple type.

The p.m. high water on November 11th registered only 8.3-ft. above datum or 2-ft. below mean tide level; it was the lowest high water observed at Southend since 1916.

The pressure distribution over the North Sea at 1800 hours on the 11th and the strong south to south-west winds are typical of many large surges in which the level is lowered.

There was an earlier lowering of level at Dunbar produced by the traction of the strong south to south-west winds further north, and this effect moved southwards.

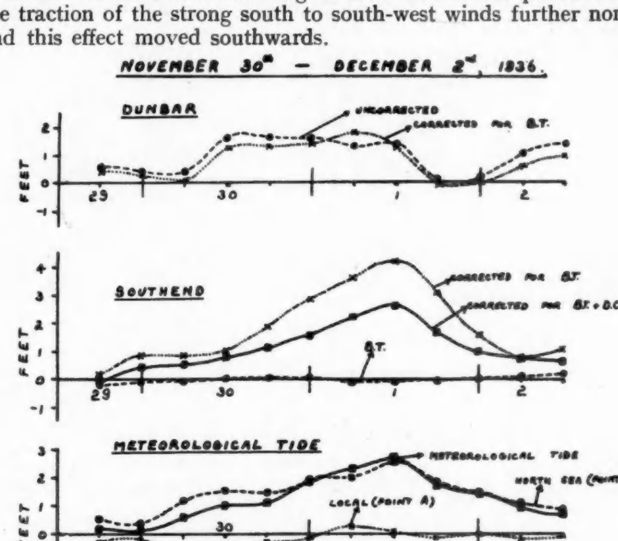


Fig. 6 (a).—Surge of November 30th-December 2nd, 1936.

The centre of the depression was north of Scotland and either stationary or moving northwards. It is much more usual for the centre of a depression in this region to move eastwards over Scandinavia; the strong southerly winds over the North Sea then veer to the north-west and north, and a large raising of level is produced. When, as in the present example, the centre does not pass appreciably east of longitude 0° a large raising of level is unusual and, before the conditions moderate, the winds veer only to a very limited extent. The local effect of the winds at Southend played an important part in producing the lowering of level on the 11th to 12th but was negligible when the level was raised on the 12th.

Storm Surges—continued

Example 2. Surge of January 1st-3rd, 1928 (Figs. 5a & 5b).

The first part of this surge, in which the level was lowered by 4 to 5-ft., was nearly identical in origin with the surge previously discussed. This may be seen by comparing the meteorological charts for 0700 hours on January 2nd, 1928, and for 1800 hours on November 11th, 1929.

There were the same strong south to south-west winds over the North Sea, but in 1928 these winds were more prominent further north; again they produced a lowering of level at Dunbar which travelled south.

Shortly after 0700 hours on January 2nd conditions as a whole appeared to be moderating and at 0700 hours on January 3rd the winds over the North Sea were negligible. **Yet only a few hours earlier the level at Southend rose to between 5 and 6-ft. above the mean.**

The curves clearly indicate that the whole of this surge came in from the north and passed Dunbar about 6 p.m. on the 2nd.

A number of examples of the same type of surge are known but their origin is still a mystery, and they are not connected in any obvious way with the winds immediately to the north of the North Sea.

They are generated when a deep depression moves north-east between Scotland and Iceland and they are closely related to the pressure changes along the shallow Wyville Thompson ridge which joins the two countries. Attempts to account for them, using the known theory for a travelling depression, have not been successful but the magnitude of the disturbance is much larger when the centre moves steadily on than when it hesitates in its movement when over the ridge. There is also a fairly consistent interval of 14 hours between the time of greatest rise at Dunbar and the time of minimum pressure at the Faroes.

This is a very good example of a surge for which predictions based on the local winds at Southend or those over the North Sea as a whole would have been a complete failure.

The surge occurred near neap tides and the time of the greatest raising of level coincided with the time of low water. It passed unnoticed at the time when it occurred.

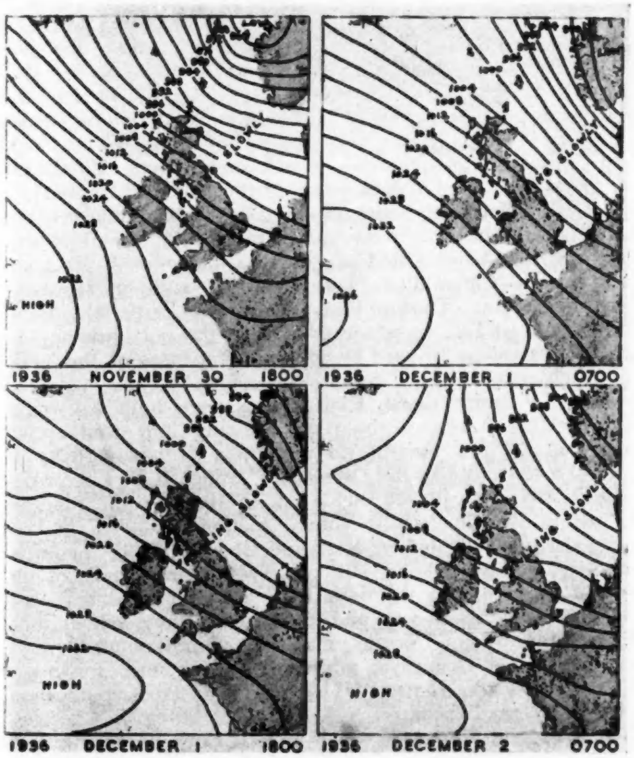


Fig. 6 (b).—Meteorological Conditions during surge of November 30th-December 2nd, 1936.

Example 3. Surge of Nov. 30th-Dec. 2nd, 1936 (Figs. 6a & 6b).

This surge is an example of a simple rise and fall in level of an unusually prolonged type.

The greatest disturbance was of the order of 4-ft. and both high waters at Southend on December 1st exceeded the level of Trinity High Water, an unusual occurrence; the p.m. high water reached 21.6-ft. above datum.

The surge was produced by a large depression centred over Scandinavia and the distribution at 0700 hours on December 1st is typical of many large surges in which the level is raised.

Usually a depression moves eastwards across the northern entrance and at first the level is lowered as in Example 1; later when the centre passes over Scandinavia and the winds veer we have the conditions of the present example.

In this particular surge there was no earlier lowering of level or eastward movement of a depression; the depression simply developed, and with it, strong north to north-west winds formed over the North Sea and further north. The effect of the external winds in piling water into the North Sea was quite appreciable as may be seen from the Dunbar curves. Inside the North Sea the local effect at Southend was slight and practically the whole of the Meteorological tide was generated by the winds over the area as a whole. There were no marked changes in the wind direction during the period of the surge, but there were large changes in the wind intensities.

7. Conclusion.

Provided predictions of the pressure distribution over the North Sea and continuous tidal observations near the northern entrance are available, it will now be seen that satisfactory predictions of the main part of the surge at Southend are possible, but there is still the problem of the short period oscillations to which reference has already been made and which have been ignored in the present discussion. This problem is due for attention in the immediate future when it is also proposed to extend the investigation along the whole of the East Coast of England.

Later it is hoped to explore similar methods in the Irish Sea and English Channel.

The daily broadcasting of weather forecasts to shipping has been a regular feature for some considerable time; is it too much to hope that in the not far distant future we shall be in a position to supplement those reports by forecasts of corrections to the predicted tides at all important ports around our coasts?

We may be assured that such a service would be greatly appreciated by shipping and the port authorities.

Commonwealth Shipping Committee

It is announced that by agreement of all the Governments represented on the Imperial Shipping Committee, the Committee will be known in future as the Commonwealth Shipping Committee.

The Imperial Shipping Committee was established in 1920, and its current terms of reference are:

"(i) to inquire into complaints from persons and bodies interested with regard to ocean freights, facilities, and conditions in the inter-Imperial trade, or questions of a similar nature referred to them by any of the nominating authorities; and to report their conclusions to the Governments concerned.

(ii) To survey the facilities for maritime transport on such routes as appear to them to be necessary for trade within the Empire, and to make recommendations to the proper authority for the co-ordination and improvement of such facilities with regard to the type, size and speed of ships, depth of water in docks and channels; construction of harbour works, and similar matters; and in doing so to take into account facilities for air transport on the routes in question."

The Committee is at present conducting an enquiry under the following terms of reference:

"To survey the shipping needs of the British Colonies in the Caribbean area, and Bermuda; to consider what shipping services will be required to meet the needs of the area in future, and to make recommendations how these services can be provided, taking into account air services existing or contemplated in the area."

The Port of Southampton

The Origin and Development of the Port and its Relations with Shipping, Shipbuilding and Ship-repairing*

By O. H. LEWIS, M.Inst.T., General Manager and Clerk, Southampton Harbour Board.

(Continued from page 225)

The Port as Britain's Marine Airport

At the beginning of 1937, Southampton was called upon to deal with a new kind of ship, the flying-boat, when the government decided that the main British marine air terminal should be located at Southampton. In 1939 the Southampton Harbour Board promoted a bill in parliament which, *inter alia*, reserved an area of Southampton Water off Netley for the exclusive use by flying-boats, and the public rights of navigation in that area were extinguished.

The Imperial Airways (now the British Overseas Airways Corporation) operated services to and from Australia, Africa and India, and eventually inaugurated a service to America across the North Atlantic, and Atlantic crossings were also made by American "Clippers." The traffic carried on the empire air routes showed considerable development.

During the war the handling of passengers and mails was transferred to Poole, but all the flying-boats continued to come to Southampton for maintenance and testing at the B.O.A.C. hangars and slipways established at Hythe.

In 1943 the Southampton Harbour Board considered in detail the post-war requirements of flying-boat services, and produced a scheme which was submitted to the Air Ministry and subsequently to the Ministry of Civil Aviation. This scheme provides for a marine alighting area situated in the triangle formed by the Lee-on-Solent foreshore, the western approach to Southampton Water, and the deep-water channel of the Solent Water. Runways having a length of 12,000-ft. and a width of 700-ft. are ready for use and no initial dredging is necessary. As the alighting area is not landlocked, additional lengths of runway are also available if necessary. A mooring basin for flying-boats is provided for by a double system of shelter consisting of an outer breakwater covering the aircraft moorings, and a pair of inner breakwaters or moles enclosing a harbour for the loading, unloading, and repairing of flying boats.

Smaller land craft employed on feeder lines could be accommodated immediately alongside the Marine Airport, and the existing terrain available for this purpose is eminently suitable for the construction of a land aerodrome.

Broadly, the scheme demonstrates that an international Class A marine airport, conforming to the most modern standards, could be established at the confluence of Southampton Water and the Solent. The scheme is receiving the consideration of the Ministry of Civil Aviation.

In the meantime, the B.O.A.C. flying-boat services are to return to Southampton, and all the necessary arrangements are in hand to that end, including the construction of a new terminal building and special flying-boat docks at the Southern Railway Docks.

Shipping

While there has been tremendous development in the port facilities at Southampton, there has been an equally phenomenal development in the quantity of shipping entering the port and in the size of vessels. When the Institution of Naval Architects last met in Southampton in 1894, the annual total gross tonnage of shipping entering the port was 3,000,000 tons, whereas the peace-time record was over 25,000,000 tons in 1938. In 1894 the largest ship using the port was nearly 11,000 tons gross, whereas the largest ship to-day is 82,673 tons gross.

Fifty years ago the largest ships in the North Atlantic service from Southampton were the American Line steamers *New York* and *Paris*, of 10,498 tons gross. To-day we have the two "Queens" of over 80,000 tons gross. In the Cape service there was the *Dunottar Castle* of 5,465 tons gross, as compared with the present *Capetown Castle* of 27,000 tons gross; and in the South American service the *Nile* and *Danube* of 5,946 tons gross, compared with the present-day *Andes* of 26,000 tons gross. Of the German ships, the Hamburg-America Packet Company's *Fürst Bismark* of 9,000 tons gross was the largest fifty years ago, while in pre-war days the *Bremen* and *Europa* of 50,000 tons were Germany's largest liners calling at the port.

The last fifty years has been a period of the greatest developments in shipping, and it has also been the period during which the major shipping lines of the world have made Southampton their base or principal port of call.

Shipbuilding

Shipbuilding has been carried on at Southampton and places in the district, such as Eling, Bursledon and Woolston, from time immemorial, and although Britain's power in shipbuilding is centred mainly in the North of England and the lowlands of Scotland, shipbuilding firms of the highest repute remain based on Southampton Water. But for its long distance from the sources of mineral wealth, Southampton Water might well have become the Clyde, Tyne or Wear, of the shipbuilding world, so deeply and firmly are its shipbuilding roots fixed in the past. For several centuries oak was the principal material for shipbuilding, and it is not surprising that, because of its close proximity to the oak forests of Hampshire, Southampton became an important shipbuilding centre. Until the middle of the nineteenth century, large quantities of oak timber were also shipped from the port to shipbuilding yards of the North of England.

The early history of Southampton as a shipbuilding centre is linked up with the King's Navy, and the earliest record of shipbuilding is that King Alfred selected the district with great care in his famous shipbuilding plans connected with his scheme to defeat the Danes. During Plantagenet times, especially in the days of Edward III, vessels were built at the port, and in 1418 Henry V caused to be built at Southampton three of the largest ships then afloat, the *Grace Dieu*, *Holie Ghoste*, and *The Trinitie*. In Tudor times, King's ships were built as well as docked on the banks of the rivers running into Southampton Water, but the first man-of-war built in a private yard by the holder of a contract was the *Devonshire*, launched by a shipwright named William Wyatt, of Bursledon, in 1692. From that year until the early nineteenth century men-of-war were built at private yards at Bursledon, Northam, Chapel, Eling, Hythe and Redbridge, and records are still preserved giving details of their size and tonnage. In the days when merchantmen were easily converted into men-of-war and the Royal Navy relied almost entirely upon them for its material, Southampton was an important Royal Dockyard, and remained so until, for reasons which are obscure, Henry VII decided that Portsmouth should be the main naval base.

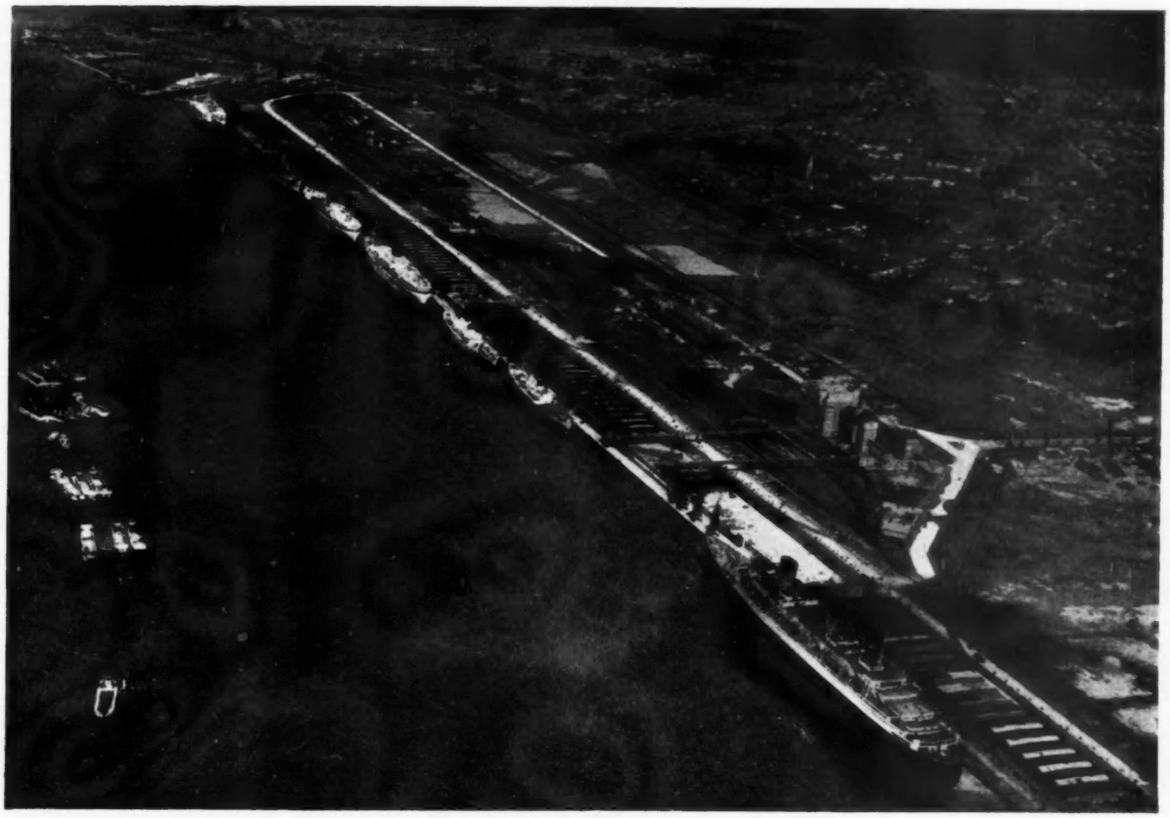
The Woolston Shipyard, which in 1904 came under the ownership of John I. Thornycroft & Co., Ltd., has been reconstructed and enlarged until to-day it is one of the best-equipped shipbuilding yards in Great Britain.

*Abstract of a Paper read at the Autumn Meeting of the Institution of Naval Architects in Southampton, on September 25th, 1947, and reproduced by permission.

Port of Southampton—continued

During the war years 1939-45 the yard was engaged to capacity building naval craft of various types, and the list of such craft makes an impressive record. It includes mainly destroyers of the following classes: "K," "H," "N," "O," "Hunt," "U," "Z," 12th Emergency and 13th Emergency class. Other vessels built included M.L.'s, L.C.T.'s, L.C.M.'s, M.T.B.'s and torpedo recovery launches. The development of electric welding in ship construction was greatly increased and considerable modifications were introduced into ship-building procedure and of Wales) dry dock was built, having a length of 745-ft., a depth of 31-ft. 9-in., and a width of 91-ft., and at that time was the largest dry dock in the world.

In 1905, the size of ships having increased considerably, the No. 6 (Trafalgar) dry dock was constructed, of a length of over 900-ft. and 100-ft. in width and 35-ft. deep at H.W.O.S.T. This dry dock was eventually lengthened to 912-ft. and served the needs of the port until 1924, when the further increase in the size of ships necessitated a still longer dry dock. This need was



[Photo, Southern Railway Company

Modern Aerial View of New Docks Estate, Southampton, with "Queen Elizabeth" and other large liners berthed alongside.

in the layout of the yards. To-day the Woolston shipyard is completely equipped for the construction of all-welded vessels and riveted vessels or a combination of the two. New plant and new machinery have been installed and, with lifting facilities ranging from 3 to 60 tons capacity, including travelling mono-tower and overhead cranes, the yard is unsurpassed by any other similar yard in the ship-building industry.

Ship Repairing

In a port of the magnitude of Southampton, where the cream of the world's liners regularly berth, it is only to be expected that the ship-repairing facilities would be of a commensurate capacity and standard.

From the earliest days of dock development the dock owners have been conscious of the needs of ship repairers and have always been abreast of requirements in providing the necessary dry-docking facilities.

Soon after the completion of the first wet docks in 1843, the Dock Company, being alive to the necessity for the provision of repair facilities for the ships they were attracting to the port, constructed Nos. 1 and 2 dry docks. The largest of these measured 401-ft. long and 66-ft. wide, with a depth of water over blocks at H.W.O.S.T. of 19-ft. 3-in. In 1854, Nos. 3 and 4 dry docks, slightly larger and deeper, were constructed; and in 1895, following the completion of the Empress Dock, the No. 5 (Prince

met by the provision of a floating dock by the Southern Railway Company. It was the world's largest floating dock, with an overall length of 960-ft. and a clear width of entrance of 134-ft., and capable of accommodating vessels of 60,000 tons displacement, and therefore, at that time, of accommodating any ship afloat. This dock was little used after the opening of the King George V graving dock, and on the outbreak of war in 1939 was disposed of to the Admiralty and removed from the port.

The culmination of dry dock development at Southampton came in 1933, when King George V opened the graving dock named after him, which had been constructed by the Southern Railway Company primarily for the new Cunard liner (*Queen Mary*), then building. The dry dock, which for many years was the largest in the world, and is still unsurpassed, is large enough to accommodate vessels up to 100,000 tons gross. The main dimensions are as follows:—

	Ft.
Length	1,200
Width at entrance	135
Depth over keel blocks at H.W.N.T. ...	45
Depth over keel blocks at H.W.S.T. ...	48½
Depth over sill at H.W.N.T.	47

The approach channel to the graving dock is the same as that serving the new dock quays and is 600-ft. wide and 35-ft. deep L.W.O.S.T. Outside the graving dock, the approach channel

Port of Southampton—continued

terminates in a turning basin about 1,500-ft. wide with the same depth of water.

Unlike most graving docks, the walls are not recessed with altars on which to rest the shores, as this method of supporting ships is no longer used for large liners. The walls are battered to provide light and air, and, to assist the docking of ships, buttresses have been built on opposite sides at 200-ft. centres. At the same time, these form a wall face to moor to when the dock is used as a wet dock.

The construction of the dock involved the excavation of about 2,000,000 tons of earth, and about 750,000 tons of concrete were utilised for the building of the walls and floor. The whole of the construction work was executed between June, 1931, and April, 1933—an achievement that probably constitutes a record.

The dock, when not occupied by a ship, will hold 260,000 tons of water, and the pumping plant is capable of emptying the dock in four hours. All the intricate system of valves and pumps is so arranged that it can be operated by one man from a control desk. The graving dock caisson, the world's largest dock-gate, has a length of 141-ft. 9-in., is 58-ft. 6-in. deep and 29-ft. 6-in. wide, and displaces about 4,500 tons of water.

Southampton's extensive dry-docking and ship-repairing facilities would be incomplete without the workshops and plant of the ship-repairing firms. Throughout the port these are numerous and varied, and their activities range from the largest to the smallest ships, naval, commercial and pleasure craft.

Conclusion

In the comparatively short compass of this paper, the author has endeavoured to compress the history of the rise of Southampton to the proud position of one of the world's greatest ports, and has recorded some of the achievements of the port administrators, dock owners, the shipping companies, ship-builders and ship-repairers. Finally, tribute should be paid to the naval architects down the centuries who designed and built the ships which have used the port, and but for the existence of which Southampton would not have risen to the great position it occupies to-day.

Liverpool Underwriters' Association

Excerpts from the 146th Annual Report

The annual report for 1947 of the Committee of the Liverpool Underwriters' Association, which was submitted to the annual meeting on the 29th ult., states at the outset that the Roll of the Association on 31st December, 1947, numbered 252 as against 245 in 1946.

Navigation of the St. Lawrence

Referring to general matters, the Committee express interest in the announcement made during the year that a 5-year contract had been signed for deepening and widening the ship channel leading to the Port of Montreal at a cost of about £3,674,442.

The Canadian Minister of Transport stated that a survey of the future requirements for the progressive development of the Ports of Montreal, Sorel, Three Rivers, Quebec and the associated St. Lawrence ship channel, indicated that facilities should be provided to handle with safety and expedition merchant ships and tankers of length up to 635-ft., beams up to 80-ft. and draft up to 32-ft. In addition it should be made possible to handle ships of 20,000 tons gross, with speeds of 15 to 20 knots.

The St. Lawrence ship channel extends a total distance of 342 miles, of which 113 miles is artificial or dredged channel and the work of widening and deepening the channel, as has been recommended, is a major step towards improving the facilities of the St. Lawrence River Ports.

Institute of Navigation

Welcoming the inauguration of the Institute of Navigation, the Committee hopes it will enable the British Commonwealth of Nations to collaborate in the work of advancing the science of navigation, so as to bring about an ever-improving measure of safety for transportation by sea and air.

Radio Aids to Marine Navigation

Dealing with Radio Aids to Marine Navigation, the Committee states the Marine Safety Division of the Ministry of Transport, together with various interested bodies, have been engaged to make navigation safer in estuaries and coastal waters by means of electronic devices; with the release of developments achieved during the war, experiments to this end have been taking place both at Liverpool and Southampton.

The Committee note with interest that the Mersey Docks and Harbour Board expect in 1948 to be the first Port Authority in the world to utilise Radar on a full scale basis for port control, as a result of which a considerable acceleration in the turn-round of ships will no doubt be achieved, quite apart from additional safety of navigation in the Mersey Channel during bad visibility.

It is understood that the Radar system now in operation for the control of ferry steamers on the River Mersey during foggy weather was the first commercial shored based installation of its kind in the world.

A considerable extension is undoubtedly taking place in the use of radio aids as adjuncts both to the control of vessels in harbour and to their safer navigation in hazardous waters during bad visibility, all of which should result in a valuable saving of time.

Theft and Pilferage

The Committee have given considerable attention to the serious problem of theft and pilferage of cargo at ports and during transit in Great Britain, as well as to the unsatisfactory world-wide position.

Meetings have been held during the year with representatives of Master Porters, Master Stevedores, the Mersey Docks and Harbour Board, the Police and Shipowners.

It is hoped that a factual report will be produced as a result of research now taking place. The Association, so far as it is able, will assist in the production of data in relation to claims paid by Marine Underwriters.

One of the chief contributory causes of losses is the increased shortage of consumer and luxury goods at home.

At the ports of Liverpool and Birkenhead, the situation is aggravated by the lack of material with which to repair the bomb damage on the dock estate and render the sheds, warehouses and dock gates more secure against illegal entry. The Mersey Docks and Harbour Board have, however, succeeded in carrying out a certain amount of essential repair work. They are also studying further active measures which would assist police and watchmen in their duties.

The police on Merseyside have made splendid efforts during the year to combat thieving in and around the docks, but the present force is too small to cope adequately with the task.

The prevailing situation is a handicap to national recovery and the Committee intends to do all that is possible to combat the evil.

So far as the international aspect of the problem is concerned, the Committee are in communication with the Theft and Pilferage Committee set up by the International Union of Marine Insurance, and will pass on to that organisation any helpful information which may emerge from the efforts which are being made to improve the situation on Merseyside.

Institute of Packaging

Referring to the formation in London of the Institute of Packaging, the Committee trust that the existence of the new Institute will result in a reduction of claims for the pilferage of packages, as the poor standard of packing goods, chiefly as a result of the shortage of proper materials, undoubtedly aids pilferage.

Notes of the Month

Pilot Vessel for Mozambique.

The former Tyne pilot cutter *Helm*, which has been sold to the Portuguese East African Colony of Mozambique, has left the Tyne for Lisbon, for delivery to her new owners.

Increased Trade at the Port of London.

During the year ended December 31st last, 39,838,647 tons net of shipping arrived at and departed from the Port of London. This shows an increase of 16 per cent. over 1946 (34,415,004 tons), and is 64 per cent. of 1938, the last normal year before the war, when the total exceeded 61,000,000 tons.

Salvage Tug Stationed at Belfast.

The German-built salvage tug *Lenamill* (ex *Arngast*), one of the most powerful tugs afloat, was recently transferred to Belfast, from which port it is prepared to answer calls from ships in distress in the North Atlantic and the Irish Sea. The vessel has been acquired from the Ministry of Transport by Mr. Henry P. Lenaghan, shipowner, Belfast. She has two Diesel engines of 3,200 b.h.p., giving a speed of 16 knots, and all her auxiliary gear is electrically-operated.

River Trent Development.

A report on the development of the River Trent so as to permit ocean-going vessels to serve Nottingham and the industrial area of the East Midlands, was recently submitted to the Minister of Transport who has promised to forward it to the new Regional Waterways Board with a recommendation that it should receive serious consideration. It is claimed that the Trent Navigation is one of the best developed navigable rivers in the country and that the scheme could be carried out economically.

New Services from Trieste.

A report in *Lloyd's List* states that a new shipping service to various parts of the world are being started from Trieste as a result of the efforts made by shipping interests to revive the port's traffic. The Lloyd Triestino liner *Toscana* (9,442 tons gross), which has been refitted in the Triest shipyard, is now on her way to Durban via Port Said on a regular service to South Africa. She is carrying some 600 passengers, mostly Czechoslovak and Austrian emigrants. The Italia Company is starting a service from Trieste to South America with the *Vesuvio* (7,176 tons gross), which leaves shortly for Rio Janeiro, Montevideo and Buenos Aires. The *Nereide* will go into the same service at the end of February. The Egyptian Misr Line is starting a regular service from Alexandria to Trieste as a result of the Egyptian-Czechoslovak agreement. Egyptian ships will carry cotton to Trieste for transhipment to Czechoslovakia, and will carry back Czechslovak machinery and other goods.

New York Pier Destroyed.

A pier and a warehouse were destroyed and two ships set on fire following a mysterious outbreak of fire on a stretch of the Brooklyn waterfront early last month. An Argentine merchant ship laden with 1,000 tons of grain, had to be towed out into the bay by tugs and sprayed by fire boats and several injured members of the crew jumped from the decks of the burning ship on to the wharf. The second ship was less severely damaged.

Newcastle Improvement Scheme Rejected.

Under the restriction of capital expenditure, the Ministry of Transport has rejected the £60,000 scheme of the Newcastle Corporation Trade and Commerce Committee for the development of Newcastle Corporation quays. The scheme, which had been approved by the City Council, provided for the improvement of existing berths, additional craneage and rail facilities, with the object of securing a faster turn-round of tonnage.

Cargo Delays at East African Ports.

Towards the end of last month, a conference of Government officials, shipowners and traders was held at the Ministry of Transport in London to discuss the serious delay now being experienced in the shipment of cargo from the United Kingdom to East Africa, attributable chiefly to congestion at the Port of Dar-es-Salaam, Tanganyika. It was stated at the meeting that Mr. P. E. Millbourn, the Minister of Transport's Adviser on Shipping in Port, will be leaving for East Africa shortly in order to investigate the position on the spot.

British Council Courses on Docks and Shipyards.

A series of 11 short courses covering education, the social sciences and a number of technical subjects will be held by the British Council in February and March this year. The courses are from 14 to 21 days in duration, and will enable a total of some 200 foreigners to make a short intensive study of the subject in which they are interested at an economical cost which varies from £16 to £30. A course entitled "Docks and Harbour Railways" will be held at Southampton from March 1st to March 20th. It will cover dock construction and management, the handling of ships and cargoes, docks railways management, dry dock facilities, the handling of passenger traffic, harbour management, pilotage, dock equipment, imports and exports and the economic aspects of the port. It is designed to cater for dock superintendents and other senior administrative dock and harbour officials. The cost per person is £30. Another course for shipbuilding students will be held at Newcastle and Glasgow from February 23rd to March 11th. The course is designed to give visitors from oversea a comprehensive picture of the ship-building industry in Great Britain. Members should be students of ship-building or marine engineering, and should have a sufficient knowledge of English to enable them to follow technical explanations. The cost per person is £22.